

Dr. *BOERHAAVE*'s
Elements of Chymistry,

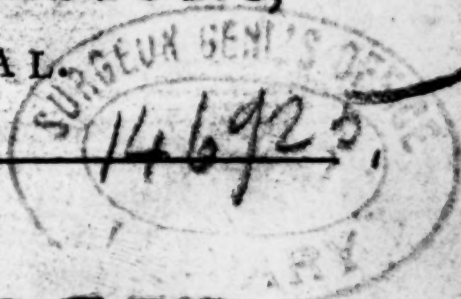
FAITHFULLY

A B R I D G ' D

From the late

GENUINE EDITION,
Publish'd and sign'd by himself, at *LEYDEN*.

With all the
CUTS and EXPLANATIONS,
as in the ORIGINAL.



To which are added,
Curious and Useful NOTES,
Rectifying several Opinions, &c. of the learned AUTHOR.

By a *PHYSICIAN*.

Dr. Strother

L O N D O N :

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P R E F A C E

T O T H E

R E A D E R S.



THE Original of these Sheets being very voluminous, and containing many superfluous Circumlocutions, contributes to raise the Price of the Books and deters the Purchasers from its perusal; but this Abridgment, I hope, has help'd those Inconveniencies, and yet, I can assure you, it contains the whole, except the Author's Dcdication, which only gives us to know how his Brother from studying Physick became a Divinc, and

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how the Author from a Student of Divinity took to Physick.

The Author calls his first Volume The Theory of Chymistry, imitating Le Febvre ; but, except his long Detail on Menstrua, little of the whole retains to this Art, being a Piece of Physicks taken from Du Hamel, Le Clerc, and some others ; and it relates as much to Agriculture or any other Art, as to this. Lemery and Freind join'd do only contain the true Theory of Chymistry, the one accounting in a Physical, and the other in a Mathematical way, for all the phænomena produc'd by Chymistry: Let Physicians, who have enter'd the Lists without a liberal Education, decry this mix'd Reasoning in all the Branches of Physick, till they are adjudg'd Ignorant, and spurn'd for these their vain Attempts: Let this short Answer give them to understand their unpitied Mistake, namely, that wherever Quantity or Motion are to be accounted

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accounted for, *Mathematicks* take place; but where *Qualities* are the Theme, then *Experience* back'd by *Experiments* serve the turn; and as sometimes *All* come in play at once, then must our *Rationale* be mix'd: Now as all *Diseases* do depend on One or more of these, how lame do such *Physicians*, as are ignorant of either, appear in their *Writings*! and if they chance to be unskilful in either, as God knows too many really are, what crude and indigested *Works* do the *Shops* abound with! I have spoke enough to such as take me, and nothing would be enough for such as don't.

I wish this *Treatise* had aim'd more at the *Correlation* between *Animal* and *Chymical* *Actions*; this is not the only *Difference* between the *Author* and me; I have sufficient *Grounds* for varying from his *Opinions*, which I may some other time clear up; at present I shall only take notice, that this *Abridgment* took its rise from *Curiosity* and a strong desire

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desire of seeing how he would appear when stripp'd of his Harangues, which I did at hours free from Business ; the Remarks I have made are fewer than might be, but are too numerous for an Epitome.



T H E



T H E
D E S I G N .



OUR desires are to learn, and mine to shew you, the advantages of chymistry.

Which I shall do by explaining to you all that is contain'd in authors, as well as all the processes.

Which is not very easy to be done, since we proceed upon things discover'd by chance, and not by rules; since a huddled collection of events, and not any general reasoning, gave birth to this art.

But I shall shew you the effects producible, and reason as well as I can, which however a *suite* of negligence in preceding artists, in forgetting many niceties, renders more difficult to me.

I shall divide these Institutions into three parts; in the first I shall shew you the origin, progress, and increase, recite the authors, shew where they agreed or disagreed, their sects, and give them their due encomiums.

In the second, I shall shew you the rules and all generals belonging to the art.

Nor do I own any other theory than what is built on observations, that are constant; nor shall I extend this further than to Particulars, which are often so confin'd, as not to be common to others.

I shall make use of the mechanicks in this theory, and of the properties common to all bodies; yet so as not to omit particular ones; as for example, *Galilæus* his laws of falling bodies are thwarted if a falling magnet happens within the sphere of another active loadstone; and *Archimedes*'s on æquiponderants in water, where Gold is suspended in Aqua regia, whilst it falls in any other liquid.

I shall therefore shew what is discover'd, and so promote the art.

In the last, I shall shew you the operations themselves, and all their varieties, where nothing shall be *repeated* unnecessarily, but the simplest shall precede, and the most compounded shall follow.

Thus the theorems in the first part will serve as a direction to understand the latter; and thus shall we arrive at perfection; since the processes of themselves wou'd be of little use.



THE
ELEMENTS
OF
CHYMISTRY.

PART I.
Of the CHYMICAL COURSE.

Concerning the HISTORY *of the* ART.

Of the Name.



It is written by the Greeks *χημία* or *χημεία*, and is reputed an antediluvian art.

So thinks *Zosimus Panopolita*, known to *Agricola*, and as *Scaliger* has it from thence, that the art deliver'd to the daughters of men by dæmons for their favours was call'd *χημία*, and in *Eusebius's* notes it is said that these dæmons deliver'd to them a book call'd *χημᾶ*, and the art it contain'd was call'd *χημία*. This fiction arises from mistaking the

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the scriptural expression of the *sons of men* for devils; as *Sibylla*, from (a) Σιβή, that is, Διδύβηλα in *Æolick*, for Διδύβηλα. in reward of love, had got the art of prophesying. So far for fictions.

Egypt was formerly call'd χημία and Ἑρμοχημία: but χημία in *Arabick* is to *hide*, according to *Borchart* (b).

Hence the name is antidiluvian, and it signified the knowledge of the works of nature, the book of that knowledge, and *Hermes* mentions it.

If we write it χημία 'tis the hidden art; if χημία, it signifies the black of the eye, that is the same as somewhat hidden (c).

Egypt the Land of *Cham* was call'd Ἀμῶν, which signifies *hidden* according to *Plutarch*.

At this time it is call'd *Chemi* by the *Cophthites*.

Hence this hidden art is call'd *Chemi*, *Chemia*, *Alchemia*, *Alkumia*, χημία, χημία, ποιητική: *Spagyria* and the *Hyssopick art* is an art to separate pure from impure.

At first it signified all natural science, and came afterwards to signify magick, and at last metallurgy.

(a) Our author mistakes the *Greek* dialects; for search and you will not find that Δ is chang'd into Ζ, nor α into υλ, nor Θ into υ. So that the whole fabulous derivation is a piece of sham-learning.

(b) If we must rely on the similitude of names, why may we not derive the word *chymistry* from the *Hebrew* חמץ *calefecit*, or from חם *calidus*, or חמה *calor*, *sol*, all which signify *heat*, and as chymical preparations are mostly done by heat, it wou'd, if derivations are of any force at all, denote the art by the means thro' which we obtain our ends; but then we ought to call the art *Chamistry*: strange trifling! The *Hebrew* חסם is *recondere*, to *hide*; but חמה is *desiderare*, to *wish for*. We see what superficial knowledge is etymology!

(c) Χήμωσις, and not χημία, is the *Greek* word.

חמץ is *multitudo*, as if it were *populous*; or *nutritius*, as if it were a *plentiful place*; but חסם is to *hide*: What a weak defence is this to prove chymistry very antient?

This

This metallurgy was first practis'd by *Tubal-Cain*, the poets *Vulcan*, *Gen. iv. 22.* for he made instruments of iron.

Brass, before it becomes malleable, requires twelve operations; and Iron requires a great deal of art to make it fit for tools.

Asia was the first place then that metallurgy was practis'd, for *Tubal-Cain* liv'd here, *Gen. iv. 22.* and compound the true and poetical history of *Tubal-Cain* and *Vulcan*, you will find, they meant one and the same person (d).

From hence it came to *Egypt*, and *Moses* knew how to mix Gold with water, (*Exod. xxxii. 20.*) an art not now known; and *Diodorus Siculus* says *Vulcan* reign'd first in *Egypt*, was esteem'd a god after his death, for having found out fire, or rather, tools of Iron.

Egypt is call'd *χημία* and *ἑρμολύμειον*, 'tis also call'd *Ηφαίστεια*, or *Vulcania*; the art *χημία* by the *Egyptians* is call'd *μύθος*, and the *ποιητικὴ* is chymistry (e).

A temple was built at *Memphis* in honour of *Vulcan*, and his symbol was a vultur: *Ηφαίστος* comes from *ἄπλω*, to burn. See *Horace, carm. I, 4, 7.* and *Plaut. Amphitr. 101, 185.*

These authorities shew us that metallurgy first begun in *Egypt*; so that the art and name are ascertain'd.

Some time after, the word *chemia* begun to signify alchemy, or that art which chang'd any metals into Gold, which shews its original to be *Arabick* by the article *al*.

(d) Here the false is fuller than the true copy of our author, for he says *תובל קין* by throwing off *תו* 'tis *בלקין*, and *Bhalcan* being pronounc'd *Valcan*, hence *Vulcan* by corruption.

(e) *Conr. c. 3. Reines. Var. Lect. l. 2. c. 5.* I should be glad to know one chymical remedy ever known till within these 200 and odd years.

Suidas, who liv'd in the tenth age, on the word *χρυσία*, writes that *Dioclesian*, who reigned the twenty last years of the third century, commanded all the books on this art to be burnt, because the *Egyptians* were inventing plots against the *Roman* empire.

And on the word *δερμας*, *corium*, he says, the *Argonauts* had a book written in leather that contain'd the art of making Gold by *χρυσία*: but as from *Pliny* to *Moses* nothing is said of this, we may believe it a fiction; for this would be bringing this art up to 13 centuries higher than our Saviour.

As to what *Pliny* (f) or *Dion Cassius* (g) write on *Tiberius* rejecting flexible Glass, or as to what *Pliny the younger* (h) says of *Caius* making Gold out of Arsenick, 'tis not to the purpose, since these shew us the art of making Glass and the drcimastick art.

I confess *Julius Maternus Firmicus*, in the beginning of the fourth century, 3. *Matthes.* 55. writes of alchemy as a known art, if the text of this author be genuine.

And *Aeneas Gazæus*, in the fifth century, talks of alchemy, or the changing of Silver and Tin into Gold, as an art well known (i).

Also *Clarius Anastasius*, in the fifth or seventh century, talks of *χρυσία* and *χρυσοκολλητής* (k).

In the seventh century, *Georgius Syncellus* treats on alchemy expressly. After this many authors appear'd on this subject in *Greek MSS* (l).

On

(f) 35. 25.

(g) 57. p. 617.

(h) 33. 4.

(i) Bibliothec. Patr. V. 2. p. 373.

(k) Voss. l. 1. p. 25. Fabric. Bibl. Gr. v. p. 313.

(l) Synesius at Leyden in L. Democriti. Sostymus l. 24.

Olympiodorus Alexand. Joan. Archifacerdos; Stephanus Philos. Oros; Sophar; Hermes; Dioscoursus Sacerdos; Ostanes; Moses Propheta; Maria Hebræa; Pelagias Philos. Porphyrius; Epibychius;

On these Greek authors see *Libarius*, especially against *Guibertus*, *Conring. de Med. Herm.* p. 21. ad 31. *Borrich. Ort. Ch.* 97. and against *Conring.* from p. 66. to 95. *Joann. Albert. Fabric. Bibliothec. gr.* and the catalogue of the library of *Leyden*.

George Agricola knew all these authors; *Erasmus* extols his works; he recites many authors that wrote on this subject in his preface.

All those authors do only speak of converting all metals into Gold, but say nothing of any panpharmacon (*m*).

The *Arabians* spoke in metaphors and in hieroglyphicks, their methods were call'd medicines, impure metals, sick men; Gold, a sound person; the dross of impure metals was call'd a leprosy; and the ignorant thought they spoke of diseases.

They call'd the instrument their philosophers stone, the gift of azoth, and those who had the secret, adepts; and they thought by it to transmute impure into pure metals or Gold.

And as chymistry by its remedies procur'd health, as *Rhazes* gave examples, and *Avicen* taught on the *Arabian* *Jalab* or distill'd Rose-water,

The 11th century *L. de Vir. Cord.* and *Mesue* confirm'd.

The chief was *Geber* call'd the *Arabian*, but was a *Grecian*, in the seventh century; he wrote of alchimy or chymistry; *Morienus*; *Albertus Magnus*; *Roger Bacon*, an *English* monk; *George*

chius; *Comarius Phil.* *Cleopatra uxor Ptolomæi*; *Cosma*; *Agathodæmon*; *Pappus*; *Heraclius*; *Salmana*; *Christianus*; *Theophrastus*; *Aretulaus*; *Claudianus*; *Sergius*; *Anepigraphus*; *Michael*; *Isis*; *Blemmidus*; *Nicephorus*; *Democritus*; *Hicrothius*; *Isaacus Monachus*.

(*m*) *Conring. de Med. Herm.* 15. 16.

Riply, an *English* canon of *Bridlington*; *Arnoldus de Villa Nova*; *Raymund Lully* of *Barcelona*; *Johannes de Rupe-Sciffa*, a *Franciscan*; *Isaac Hollandus* and *Johannes Isaac Hollandus* of *Stolk* in *Holland*; *Basil Valentine*, a monk of *Erfort*, a most expert alchymist, who aim'd at an universal medicine.

What increased the reputation of chymistry was the curing the venereal disease with Mercury by *Carpus*, when the schools abounded with words without meaning, given from *Galen* and the *Arabians*.

The old physicians grew out of date, when all their elaborate works on causes, signs, diet, and remedies were baffled, and diseases cur'd with one remedy.

However, if fashion prevail'd for a while, their vanity appear'd at length, as may appear by *Paracelsus* and *Helmont's* boasts.

Paracelsus was the son of *William Hohenheim*, a trifling licentiate of physick, and bastard son of the master of the *Teutonic* order, who had a rich library, born at *Einsidlen* (which signifies a desert) in *Switzerland*; he was call'd from his town, an *Eremite*, by *Erasmus*; he was said to have been an eunuch; he was taught by his father, *Trithemius*, and *Sigismund Fugger*, where he owns he learn'd his chymistry; he studied the adept philosophy under the best masters, who conceal'd nothing from him; then he travell'd thro' *Germany*, *Italy*, *France*, *Spain*, *Portugal*, *Poland*, &c. and learn'd every where *arcana*; he learnt from *Basil Valentine*, tho' he conceal'd his name, the three principles of Salt, Sulphur, and Mercury; he travell'd into *Russia*, was taken by the Cham of *Tartary*, sent to *Constantinople*, and was said at his 28th year to have the philosophers stone; he

he serv'd as surgeon and phyfician at fieges and battels ; he admir'd *Hippocrates*, hated the fchool jargon and the *Arabians* ; he admir'd Opium and Mercury, and cur'd great diftempers, which others could not : he became famous and bold ; he cur'd *Frobenius* at *Bafil*, was invited thither, and taught philosophical (n) phyfick in *Latin* and *German* : he was known to *Erafmus* ; he expounded his own books on Compositions, Degrees, and Tartar, where he talks much, according to *Helmont*, to little purpofe ; burnt *Galen* and *Avicen*, and faid, if God pleas'd, he would confult the devil ; he had many fcholars, fome of whom he maintain'd, who us'd him ill ; he commends fix of them ; he cur'd the canon *Liechtenfels*, who inftead of rewarding him, as he promis'd, jeer'd him, and faid he had given him only three moufeturds (*Laudanum*) ; he fued, and the judges allotted him fo little, that he call'd them unjust blockheads, for which he was forc'd to leave the town ; he left *Oporinus* his laboratory ; he went into *Alface* with *Oporinus*, and was as happy in curing as he was diffolute, as *Borrichius* tell us ; he allured the learned *Oporinus* along with him, in hopes of diving into his fecrets, but in vain, for he return'd to his family in *Bafil* : the caufe of *Oporinus*'s leaving him was this, he was call'd to a countryman, but wou'd not leave his liquor till morning, he then went and ask'd if the fellow had taken any thing, they faid, only the facrament ; Then, faid he, if he has apply'd to another phyfician, he wants not my help : he had forgot his *Latin*, wander'd about, drank unmercifully, grew dirty, and dy'd at *Salisburg*, in an inn, the 24th of *Sept.* 1541, aged 47, altho' he promis'd

(n) Anno 1527.

himself long life by his elixir: he wrote some works (o).

Helmont of *Brussels*, of noble parentage, born 1577, studied physick, ended his philosophy 1594, lov'd the antients, read chirurgical lectures at *Lovain*; was made doctor 1599, cur'd himself of the itch with sulphur, left his country, learnt chymistry, sold his all, and gave it amongst his relations; he married a rich wife, and liv'd at *Vilvoord*; he run the risque of his life by his experiments; he practis'd without fees; and says he cur'd thousands yearly; he spent fifty years thus, was invited by the emperor *Rudolph*, but refus'd it; he could not cure his sons of the plague, nor his eldest daughter of a leprosy, nor his wife nor maid, nor himself of poison: his son publish'd a large volume in *quarto*: he dy'd of a fever *Dec. 30. 1644.*

I conclude that neither this author nor *Paracelsus* had any universal medicine; nor did they live to an old age, as they hop'd.

Next came *Sylvius*, *Otto Tachenius*, and others, who introduc'd chymistry into the practice of physick; a catalogue of whom I here give you; to wit, *Crollius's Basilica Chymica*, *Beguini Tyrocinium Chemicum*, *J. Hartmanni Opera Medico Chymica*, *Glafer Traité de la Chymie*, *La Febure Traité de la Chymie*, *Lemery Cours de Chymie*, *Le Mort Chymia Medico-physica*, *Barchuysen Pyrosofia*, *Geber* reprinted, *Georg. Agricola de Re Metallica*, *Lazar. Erkern Aula Subterranea*, *J. R. Glauberus*, *Joach. Beecker Metallurgia*, *J. Kunkel*

(o) Of Surgery; of Apostemes; of Tartar, &c. de Archidoxis; of Cures; of Health, and Elements of the Generation of natural Things; of Suppuration; of Signs, Characters, Adeptes, Bleeding, the Origin of new Diseases, and Magick.

Philo-

Philosophia Chymica, Ol. Borrichii Docimastica Metallica, Morienus, R. Bacon, G. Ripley, Raim. Lully, Bernardus, J. Is. Hollandus, Is. Hollandus, Basil Valentin, Artephius, Theatrum Chymicum, Turba Philosophorum, Paracelsus, Iren. Phialetha, Michael Sendivogius, Helmont, Boyle, J. Robnius, Cox and Slare, Homberg, Geoffrey, G. Ern. Stahl Fundamenta Chymicæ, and Hoffman's Observationes Physico-chymicæ.





P A R T II.

On the THEORY of the Art.

CHYMISTRY is an art shewing how to change bodies by proper instruments, that their effects, and the causes from these effects, may be known.

'Tis an art, because it gives rules how to act, and requires a knowledge and acts of the understanding.

Its objects are all bodies that are or are made sensible. We divide them into three classes; *first*, Fossils or Minerals found in the Earth.

On M E T A L S.

These are the heaviest Fossils, they flow, cool, and are malleable. There are six, Gold, Silver, Copper, Tin, Iron, and Lead: To these the antients added Quicksilver, tho' it be not ductile nor fix'd.

The *Persians* gave the same characters to the Metals as to the Planets; ☉, ☿, ♀, ♃, ♂, ♄, ♀.

The marks are hieroglyphicks, for + shews sharpness; ☉ perfection, no sharpness; ☿ half Gold; ♀ half perfection, no sharpness; ♃ the middle part Gold, the upper Silver, the lower sharpness, as if it were partly Gold, partly Silver, partly sharp

sharp and corroding; ♀ Gold and sharpness; ♂ Gold and half sharp; ♀ half Silver and half sharp; h partly sharp, partly Silver; ♂ Gold and sharpness.

The surest mark of Metals is their specifick gravity; and it stands thus with respect to Water; Water 1 ☉ 19 +; ♀ 14 +; h 11 +; ☾ 10 + or 11 +; ♀ 8 + 9; ♂ 7 + or 8; ♀ 7 +; Granat 3 or 4; Glafs 2 or 3: hence if Bodies weigh heavy, they are metallick; hence we see the difficulty of transmutation, and which, if any, is the most likely to resemble Gold.

☉ is the heaviest Metal, purest, most fix'd, and incorruptible, losing not a grain in an ounce in two months on the fire; it alone resists ♂ and h; 'tis so ductile that gr. i. gilds 36 inches square, and 24 square lines. 48 ℥. of Silver are gilded with 3i. of Gold; and one grain will make 500 feet in length; 'tis soft, not very elastick, nor sonorous; 'tis red, when melted, and *Madagascar* Gold melts like Lead; preparations of Salt dissolve it, it joins in with Quicksilver, if dissolved in Aqua Regia, and precipitated with Salt of Tartar, it fulminates; it neither rusts nor exhales; sometimes 'tis found pure, at other times mix'd with a white glebe, speckled with black spots, and Vitriols are found join'd to it.

It is separated from the Glebe by a reverberatory heat, by boiling in Water, by Quicksilver mix'd, by rubbing it with Quicksilver and Calx of Vitriol, and then by boiling in Water, by Aqua Regia, by Salts, or by washing in Water.

Quicksilver is next to Gold in gravity, unmix'd, volatile, divisible into small spheres, but not malleable, unites with Gold, Lead, Silver, but hardly with Copper or Iron, dissolv'd by Aqua Regia or Fortis.

Altho' it approaches nearest in weight to Gold, yet unless we can fix it, it is difficult to make it resemble Gold.

It is found chiefly in *Friuli* in a liver-colour'd stone, or in earth, or in round stones, or in Cinnabar.

It is separated from its glebe by sublimation, sifting and washing in Water; if it is found pure, it is call'd Virgin Quicksilver.

Lead is next in weight to Quicksilver, 'tis unmix'd, it fumes on the fire, and pierces thro' the vessels, and is not fix'd; 'tis the softest of all Metals, the least elastick, not sonorous, and very ductile; flows with a gentle fire, vitrifies soon, throws up light dross, soon congeals again, consumes all Metals save Gold and Silver; it dissolves in (a) Aqua Fortis, not Aqua Regia; it affords a sweet Salt; it is found in many places in *Europe*; its ore is ponderous, and is half Lead, it contains Silver.

Silver in weight is next to Lead, 'tis unmix'd, is fix'd, and wastes not in the fire, 'tis ductile, smelts, is dissolv'd in Aqua Fortis; it is depurated with Lead and flies not off, but with Antimony not so: it generally has a mixture of Gold in the ore; an antimonial Sulphur consumes it, Quicksilver tames it, which neither Salts nor Lead does, it unites with Quicksilver, and by sublimation you regain the Mercury.

Copper is next to Silver in weight, 'tis not so unmix'd as the preceding Metals, for 'tis somewhat volatile, but tolerably fix'd; 'tis ductile, elastick and sonorous, it grows red hot, then it melts, and if a drop of Water falls among it, it flies and endangers the workmens lives (b); any

(a) The weaker acids dissolve it soonest; moreover, it is known to contain Silver in it for the most part.

(b) And I'm told the same happens to all Metals.

acids dissolve it, and it gives green Crystals, with Antimony and Lead it turns into Scorix or Glass, and flies off in smoak; it is found in many places, in a stone: it passes 14 furnaces ere it becomes pure; it often contains Silver, and Vitriols of all colours.

Iron is next to Copper in weight, 'tis less simple or unmix'd than the other Metals, for it affords Sulphur and flames; 'tis fix'd, but loses weight in the fire; 'tis ductile, and sonorous; it grows red-hot ere it melts; 'tis dissolv'd by any Salt, and grows rusty; with Antimony and Lead it flies all off; 'tis drawn by a Loadstone; 'tis good in medicine; it grows every where, in marle, in stone, 'tis burnt ere 'tis got; 'tis often found in green Calcanthum.

Tin is the lightest of all Metals, mix'd with Sulphur, loses in the fire, ductile, not much elastic nor sonorous, flows easily, and hardens as soon, is dissolv'd with any acid after calcination, but in the ore only by Aqua Regia; it mixes with Antimony and Lead, and is hardly separable but by Copper; it approaches near to Silver; 'tis found plentifully in *England*, in a stone or yellowish glebe; 'tis got by burning, bruising, washing and smelting (c).

The history of Metals shews us, 1. That Metals are different from all other bodies, being the highest is doubly heavier than any other: 2. Hence it were foolish to pretend to transmute any body not metallick into Metal: 3. The weight shews the affinity of Metals to each other: 4. Nothing then resembles Gold nearer than Quicksilver: 5. The other properties, to wit, colour, malleableness, fixity, &c. may be the more readily

(c) *Britain* is from *Barat anac*, which in *Syriac* is the *Field of Tin*: Why not from *ברה* *ager*, and *אני* *navis*.

transmuted: 6. Gold then may be made of Quick-silver and some other simple principle: 7. Other Metals may be made of these: 8. And may be resolv'd into them: 9. That may be done by Quick-silver, some Salt or Fire: 10. Mercury then only by destroying its adjuncts may be transmuted into Gold: 11. Nor can any other Metals than the six named be made: 12. The weight then prevents cheats and spurious Metals: 13. All Metals when melted resemble Quicksilver in colour, solidity, attraction, mobility, and flexibility; Mercury is fusible with a small heat, Tin with a greater, Lead with a greater than Tin, Gold and Silver with yet a greater, Copper with a greater, and Iron with the greatest of all.

Of S A L T S.

Next to Metals we shall treat of Salts, call'd concreted Juices; all Fossiles that flow on the fire or melt in water are call'd Salts; so (c) simple that each particle is alike in taste.

The natural Salts are Sea Salt, Sal Gem, or Salt of Fountains, Salt-petre, Borax, natural Sal Armoniac, Alum, and the Acid of the Mines.

Sal Gem is taken out of the earth; the *Salt of Fountains* is got from water; *Sea Salt* is Salt crystallis'd from Sea water: These three are of one and the same nature, for they all dissolve in $3\frac{1}{4}$ of water, run in the air, give like crystals, *sc.* cubical, parallelopipedal or pyramidal, being put to Aqua Fortis dissolve Gold, give out an acid spirit, leave at bottom an austere fattish liquor, crackle and flow in the fire, are not chang'd in it, give no alcali, nor do they putrefy, &c.

(d) Uncompounded similar.

Salt-

Salt-petre is of a prismatical figure, dug from the earth, melts on the fire, 'tis fixt, affords little water ; with any sulphurous matter it deflagrates ; it proceeds from animals putrified that use no Sea-salt ; hence from dungs, &c. 'Tis dissolved in $6\frac{1}{3}$ of water.

Borax ; its figure is various, dissolves in 20 parts of warm water, runs on the fire into scum, is bitterish, gives out water, promotes smelting, and foders.

Sal-armoniack, got in *Libya*, near *Ammon's* temple, and Mount *Vesuvius* ; the factitious is from Soot, Bittern, &c.

Acid Salt is every where in the bowels of the earth, uniting with metals into Vitriols, with oils in Sulphurs ; 'tis this Salt that in burning Sulphur choaks the by-standers.

(e) *Alum* is got from a Stone that contains a Bitumen, expos'd to the air, that runs into powder, is burnt, dissolv'd in water, and precipitated with an alkaline Salt ; so 'tis a new Salt from air, alcali and a fossile Salt : The matter that is precipitated is separated, boil'd in water, thicken'd in a leaden vessel, put into a hoghead in a cool place to crystallize into octohedral crystals that are acerb : Its acid Spirit resembles spirit of Sulphur, its *terra damnata* resembles Bole, which calcin'd with three parts of any combustible matter, gives a phosphorus (f). Hence spirits of Salt, of Nitre and Sulphur are all the acids extant.

(e) Spirit of Sulphur and Chalk make an Alum by crystallization.

(f) A Mistake ; for Spirit of Vitriol is different from all, as experiments convince us.

Of S U L P H U R S.

Brimstone is hard, melts, flies off by fire, burns blue, and its steams choak. *Live Brimstone* is yellow as Amber, red or ash-coloured; *common Brimstone* is got out of the Pyrites with fire, *per descensum*; it is composed of Oils of Calcanthum, Alum and Sulphur *per Campanam*, and some oily matter combin'd; 'tis called Resin; it is sold in rolls, which are made by often melting it, and scumming and pouring it into wooden models.

Orpiment. The Orpiment of the ancients, called now Realgar, Sandarack, and Red Arsenick, differs from our modern Arsenicks; the first is not so hurtful as is said, but the latter is poisonous; for the white Arsenick is the flowers of Cobalt calcin'd with fix'd Salt and Flints; the yellow is the flowers of Cobalt calcin'd with that of common Brimstone, and the red is the flowers of the same Cobalt calcin'd with $\frac{1}{2}$ of Brimstone; the latter then is poisonous, nor was it known to the ancients, its preparation being not discovered above 200 years.

Petroleum is a stinking oil from the rocks and waters, suppos'd to be a Bitumen, melted by subterraneous fire.

Naphtha; it is a thinner Petroleum called the flower of Bitumen.

Asphaltum is thicker than the two preceding, swims on waters, and burns furiously.

Jewish Pitch, *Bitumen Judaicum*, being melted, becomes as hard as Pitch; 'tis heavy, fusible, mixes with any oil, and is inflammable.

Pissasphaltum is betwixt Pitch and Asphaltum; 'tis black, smells strong, and differs from the others in degree.

Jet, Gagates is black Canal Coal found in *Lancashire*.

Lithanthrax, is a mixture of Coal and Stone; it is our Sea-coal, and needs no description.

Amber, Succinum, Electrum, is a Bitumen made of Salt and Oil; it is yellow, white, black and red.

Oil of the Earth, Oleum Terræ; it is kept by the kings of *Asia*, and seldom brought hither; that which we have, is made of Oil of *Cocoanuts* express'd, and some earth mix'd; so may our *Barbadoes Tar*.

Of S T O N E S.

They are a hard friable Fossile, that neither fuse in the fire, nor melt in water. They are divided into *pellucid*, such are Gems that are like Glass, are hard, simple, hot, easily fus'd, and seem to consist of fire, earth and salt; *Crystal* resembles fine Glass, 'tis hard to melt; *Diamonds* are not to be melted, are the hardest Gem, and the most resplendent. *False Diamonds* are less solid and shining. *White Sapphire* resembles a Diamond, so does a white *Indian Amethyst*, as *Topazes* and *Chrysolites* being deprived of all their colour do; the *Astroites* is referr'd to pellucid Gems; coloured Gems have somewhat metallick in them, as fictitious ones have. The *Amethyst*, *Beril*, *Carbuncle*, *Chrysolite*, *Granate*, *Hyacinth*, *Opal*, *Ruby*, *Sapphire*, *Emerald*, *Topaz*, and coloured *Crystals* are referred hither. What gives a value to all Gems, is their hardness and glistening. *Semiopac* are the *Achates*, *Sand*, *Astroites*, *Armenian Toadstone*, *Carneol*, *Chalcedonian*, *True Jasper*, *Lapis Lazuli*, *Nephiticus*, *Cat's-Eye*, *Malachites*, *Onyx*, *Sardian*, *Sardonyx*, *Selenitis*, *Turkey-stone*; and the value of these is enhanced

by their solidity and colour. The *Opac* are Eagle-stone, Alabaſter, Amianthus, Belemnites, Lime-stone, Blood-stone, Jasper, Lapis Judaicus, Touch-stone, Load-stone, Marble of all ſorts ; Ophitis, Osteocola, Pumice, Whet-stone, Mill-stone, Flint, Specular - ſtone, Emery, Talc, Tripoline - ſtone. Some of theſe are convertible into Glaſs, others not.

Earths that are made into paſte with water, are Boles, Marle, Fat of the Earth, Fullers, white Bole-armoniac, of Chio, Lemnia, yellow Meletana and Radele, Samian, Selinufan, Scald and Tocay ; ſome leſs fat, are Chalk, Ochre, and fat Clay.

Of S E M I - M E T A L S.

They are Vitriols, or Metal and Salt joined together ; ſuch are Copperas, Colcothar and all Vitriols. The moſt common are of Iron or Braſs ; tho' the air makes Tin and Lead into Ceruſs's ; but Copperas and Verdigreaf are the commoneſt.

The ſame acid diſſolves either Iron or Braſs ; Vitriol and Sulphur are found together, and therefore the acid Spirit does frame the Vitriol.

There are five ſorts of Vitriol ; the *green* from Iron ; the *blue* from Copper, the *white* is Iron higher digeſted ; *Colcothar* is Iron ; *Hungarian* or *Cyprian* is blue, and is Copper ; all made with an acid : From Sory we get a Vitriol by water. Melanteria is a black cauſtick Vitriol.

Some Acid in water in the Bowels of the Earth eroding the Metal, gives all theſe Vitriols.

Some Semi-Metals are from Metal and Sulphur ;
 1. *Native Cinnabar* is a Coalition of Sulphur and Quick-ſilver, as *Analysis* ſhews. 2. Antimony is Sulphur and a metallick Earth of a peculiar kind, which is brittle, volatile and of a golden colour ;
 and

and it is *arsenical*. 3. *Bismuth*, its Metal resembles Silver, but it is brittle; Zinc resembles Bismuth.

To Semi-Metals may be referred *Armenian Stone*, *Cyaneus*, *Lazuli*, because they have metallick Veins in them; as also the *Hæmatitis*, for it abounds with Iron and sublimes; so the *Loadstone* has Iron in it: *Ochre* is Iron and fat earth.

We see then what are the principles of Fossiles, to wit, Metals, Sulphur, Salts, Earth, &c.

Of *VEGETABLES* or *PLANTS*,
or *HYDRAULICK BODIES*.

They suck their nourishment thro' pipes, and differ plainly from Fossiles; and their receiving their nourishment from the root, distinguishes them from Animals; their solid parts are Earth glued together. All their parts differ in virtue; the *Root* is design'd for fixing the Plant to the ground, and receiving nourishment; for that end it is porous, and resembles the *Lacteals* in Animals; the juice is only earth and water, crude but heterogeneous, not resembling the proper nature of the plant; these juices ascend into the plant, as is seen by piercing *Birch* in *March*, and then they are changed into the proper nature of it; the *Leaves* are the lungs, they are full of vessels, and are thin and exposed to the air; the juice they sweat out at night is a viscous juice, such as honey, wax, &c. The *Flowers* afford a juice fit for nourishing the Seed, as also honey and wax; its juice is grateful to the Seed. The Seed is the embryo of the Plant, it has a *Placenta* and a *Cotyledone* or more, which is the *Funiculus*; this *Cotyledone* contains a *Balsam* which is partly viscous and partly spirituous, the first hinders the nutriment flying off, the other serves to fecundate

it ; the viscous part never enters the Seed, but the spirit is a quintessence for its refreshment. The *Trunk* requires an oil to keep it supple ; the *Bark* contains a fat and thicker oil, which affords an Acid ; this defends the tree from injuries of air and water ; it thickens into Balsams, Gums and Resins. The Cinnamon, the Barks of *Peru*, of Capers, Tamarisc and others, make this plain. Each Plant has its *peculiar Juice*, in which its specific virtue resides : If the greater Celandine be prick'd, you get a golden juice in which its virtue resides ; if you prick the Poppy, a milky juice issues, which is Opiate. In like manner, in the Aloes ; nay each part of the plant has its *peculiar Juice*, which should be known to those who practise. In general, Plants afford a spirituous or soapy Oil, an Acid, and Alcaline fix'd and volatile, and a neutral Salt as well as Earth.

Of ANIMALS.

The third species of bodies that are the subject of Chymistry, is Animals, where I only understand the corporeal parts ; they are hydraulick bodies also ; in them the Lacteals are as roots, the Food is as earth, the Mouth is the pores of the root ; so that we resemble, as do all Animals, a Plant in this affair : The eggs of Birds have their Placenta to suck in nourishment ; so far Plants and Animals agree : We see Plants grow in waters, on earth, and on both ; we also see aquatick, terrestrial and amphibious Animals ; their matter is alike, for their nourishment is ; as in the Chyle, so in the Juices of Plants there is a native crudity, that can't be called an animal or vegetable juice, but which the more it circulates, the more it is chang'd : In Animals there is a Spirit residing in the subtiler Oil, that distinguishes one individual

dividual from another, as may be seen in dogs smelling out their masters in the greatest crowds: Animals do also abound with water; Salts also are found, none fix'd nor volatile but by fire, nor are acid Salts ever found. No Alcalick has been found, altho' the water from five days suppression was tried (g). *Putrefaction* makes all alcalick, the natural resembles Salt-Armoniack, tho' somewhat different: Having essayed the Salt of Animals, I find it a saponaceous, volatile, fix'd and oily, and apt to putrify: and the Urine affords a fix'd Salt, by burning, which is from the (b) Sea-Salt in it: And if some have tortured the Blood, and found an Acid in it, this is from the Sea-Salt in it. Animals that use no Sea-Salt have no Acid in their Blood nor fix'd Salt.

Chymistry finds Animal Oils very various, some are very subtile, miscible with water, and easily made volatile; others are fatty and smooth, and fit for lubricating, void of Salts; others again saponaceous; another is mixt with earth, is hard to be distilled, and is tenacious and unites the parts, another is fiery, called *phosphorus*, and flames and leaves an Acid behind (i).

They contain also earthy parts, which give solidity to bodies: The earth of Vegetables and Animals don't differ, for Cupels are made equally of both.

These are all that are found in Animals; yet confound them together, and you can't produce

(g) I have found Serum turn Syrup of Violets green, and sublimate water white; therefore it contain'd a volatile Salt.

The fix'd and acid Salt are united together into an armoniacal or saline Salt; for fix'd Alcalines attract Acids stronger than Volatiles; therefore no fix'd Salt, nor any Acid are found separate, but may be separated chymically.

(b) He forgets this in the sequel, and denies that Sea Salt has any fix'd Salt in it.

(i) All Oil is the same, but only varies by mixtures with other Bodies.

a liquor like what you draw them from ; Bile, Semen, Spirits, Milk, Fat, Lymph, Spittle, Urine, and all others differ from each other, and all are separated from the Blood. There is no difference between the Elements of Plants and Animals, their structures only differ. So far of the objects of Chymistry.

Chymistry handles all Bodies of the three Kingdoms ; it acts by motion, and either unites or separates Bodies by Commistion or Fire. *Motion* produces strange varieties ; we may wonder how from so few principles such varieties happen, but consider Combinations, consider the Magnet and its Phænomena ; consider Menstrua, and you will be convinc'd.

Consider how the figure of Iron being chang'd, produces Keys, Knives, &c. and how many effects are produced by this one change, the matter being unchang'd.

The simplicity of the chymical operations, which are calcining, fixing, vitrifying, subliming, fermenting, putrifying, digesting, depurating, uniting, and the like, does not hinder, that a vast variety of effects may be produced from thence.

Parts were not not such in Bodies as they appear when separated ; their effects are not the same as those of the compounds ; we can't reason from the one to the other (*k*).

When we have divided Bodies into their Atoms, or initial Corpuscles ; Art goes no further, unless we compound them again.

We never get the Elements pure, Chymistry yet never perform'd this feat.

(*k*) Why so ? Compounded Bodies indeed can't act like simple ones, but whenever they are made use of, they act in a compound *ratio* of their various Components.

Fire may perhaps be the purest, but Water, Air and Earth are compounded; you can divide the simplest Bodies, as Water, Spirits, Salts and Alcohol of Wine into different matters; nor can we reproduce the same substances, as blood, &c. from whence they were drawn.

Let us not extol Chymistry beyond truth: Its operations are limited and determined; Bodies were not the same in the Bodies as we see them produced; there's no Spirit of Wine, for example, to be had without fermentation, which changes Bodies.

There is a *Spiritus Rector* in all Bodies, which gives the individual smell or taste; 'tis so fine as not to be caught, but flies off into the clouds, and returns and impregnates other Bodies again; this Spirit resides in the subtile Oil of Bodies, which flies off at death; 'tis not above 8200 parts of this Oil; 'tis so active that 'tis called Son of the Sun, Vital Spark, &c. But I will produce an example of this affair; Distil Cinnamon-water, leave it open it loses its fragrancy, but no weight; expose the Oil, it loses its fine odour, but loses little or no weight, what flies off is the *Spiritus Rector*. Some (1) pretend this Spirit is in Metals also.

The products of Chymistry are reduced to four classes, to wit, *Extracts* (as of Wormwood of Steel, distilled Waters, Decoctions, Inspissations and Tinctures) *Clyssi*, (Soaps, &c.) *Magisteries* and *Elixirs*. The explication of these may be seen any where.

(1) This *Spiritus Rector* is a sort of an Ubiquitarian by our author's account: however it is what others call the most volatile and ethereal Oil.

Of the Use of CHYMISTRY in NATURAL PHILOSOPHY.

By help of the fire we discover what Bodies are compounded of ; Chymistry helps us to discover the properties of Bodies, by knowing their Elements ; mechanical Philosophers indeed have discovered to us the common properties already ; as of the Magnet, &c. but Chymists alone must detect, by their experiments, peculiar appearances, such as Ignitions, Explosions, Effervescences of Gunpowder, Phosphorus, Vitrication, Fermentation, and the like ; they spurn at substantial Forms, and search after the *Phænomena* peculiar to each Body, they laugh at all occult Qualities, they shew their appearances to the eye ; indeed they don't pretend to explain a *plastick Power*, but that once granted, they proceed on experiments which they owe to a *Verulam* and a *Boyle*.

Of the Use of CHYMISTRY in PHYSICK.

It shews us that the Solids are Earth and a glutinous Oil, to which a little water is applied, deriv'd from our nourishment : It shews us the nature of our Fluids, and the Thermometer shews us the degree of Heat in us.

And as the Hydraulicks shew us, and discover daily more Phænomena on the Motion of the Fluids within our Vessels, so does Chymistry daily discover new properties in Bodies, both which advance the Physiology very much : I speak of true Chymistry. Anatomy belongs to Mechanicks, the Motion of the Fluids to Hydraulicks, Chymistry shews the peculiar attractions and other properties of Bodies.

It

It conduces towards *Pathology*, because our Juices grow thick, move slower or faster by mixtures, grow acrid many ways, are dissolved, do putrify, and such like, and we can't explain these without Chymistry.

It helps the *Prognosticks*; for how can we explain the greater frequency of the Pulse, the Colour, Taste, Contents, &c. of the Urine, the nature of the Sweats, Spittle, Pus, Fæces, &c. without its assistance? When the Pulse augments the Heat by its frequency, the thinnest parts fly off, the rest thicken, the Oils are dissolved, are made acrid, volatile and putrid; the Salts are also render'd volatile, and from gentle and saponaceous, become caustick.

It guides us in the *Dietetick Part*; for without its knowledge we can't guess how persons that exercise too much have a putrid Blood; how Acids and neutral Salts profit such; how the sedentary want exercise and things of easy digestion; all which, and many more, Chymistry accounts for.

As to the *Curative Part*, it conduces mainly; for we can't give victuals without knowing their principles, which ought to be contrary to any reigning preternatural state; Remedies are prepared by it that correct and expel, lenify and restore. I desire you to read my *Methodus Modendi, Verulam, Boyle, English and French Transactions*, the *German Ephemerides*, *Bohnus* and *Hoffman*; I omit *Sylvius* and *Tachenius*, because they stretch'd its use too far; and read my *Aphorisms*.

Of the Use of CHYMISTRY *in* MECHANICAL ARTS.

By Mechanical Arts I do not understand Geometry, but such Arts as require the dexterity of
the

the hand : As to Painting, the delight of Princes, Chymistry helps it very much. Thus Ultramarine, the most beautiful blue, is made out of Lapis Lazuli, so is Smalt, another blue ; as also the beautiful green, and another blue dearer than Gold ; all which are immutable by the Air ; so are Lacquers, and other black colours made use of by Painters, all made by the Art of Chymistry ; likewise Enamelling, which crusts over Gold like unto Glass, made of a metallick Matter and fix'd Salts. Painting likewise in Glass, which formerly was used for Church Windows, as we see in *Tergow*, and which now is lost, if ever, must be restored by Chymistry.

Dying also is performed by this Art, which requires three things, to wit, washing with Lies, digesting and beating ; the Lies are made of Urine, fix'd Salts, Soaps or Gall, which take off the oily parts. *2dly*, The grinding of the Colours, so that they may penetrate well ; *Cornelius Drebell* found out a particular art of dying the *couleur de Feu* or Scarlets, by mixing Cochineal and Spirit of Nitre, and boiling them in a Tin Vessel along with Water ; without the latter circumstance, the Spirit of Nitre would have eroded the Stuffs. *3dly*, The colours must be beautiful which this art teaches to make : I remember some time ago to have shew'd to Masters of this art, colours produced from Copper so lively, that they wished they could dye their cloaths of so beautiful a colour, and there is no doubt but this may be improv'd.

Glass-making, which is most useful to Mankind ; by Glasses old eyes and short sights are assisted ; by this we are able to see all things plain, being at the same time defended from Heats and Colds ; by this we keep things for ever, nothing corrodes them, even the Alkahest does not touch them ;
it

it was improved in *Agypt*; in *Tiberius's* time it was made malleable, and at *Venice* and in *England*, it is made very fine, of Sand, Flints and other Stones, along with fix'd Salts or Ashes of Plants, which if too many, make the Glass finer, but it's apt to crack, and makes Bodies put into them to corrupt; whereas in Glass that is green, green Tea, v. g. will remain uncorrupted for ever; hence for keeping things chuse green Glass. Read *Neri*, *Agricola*, *Merret*, and *Kunckel*.

As to making artificial Gems, Chymistry has invented how to strike Glass with all colours, and if we could make them one and a half heavier, they would equal true Gems, but Lead makes them softer; whereas if to this weight we could find how to make them harder, and strike a fine colour, they would be valuable; but all this must be found out by Chymistry; for this end Crystals may be made use of; and some have endeavoured by heating them, and plunging them into metallick Tinctures to strike their colour, but thus made they are apt to crack; others have cemented Crystals with Metals, and others again have made metallick Pigments, crusted Crystals with them, and melted those in the fire.

Chymistry shews how to make Metals fit for the various uses of mankind; I speak not of Transmutation; if Gold be too pale, the Regulus of Antimony gives it a fine colour; if it be too flexible, it is made harder by Copper, as is Silver; Brass is made by Copper and Lapis Calaminaris; Princes-Metal is made of Brass and Zinc, which being gilded, looks like Gold; and how to gild or silver baser Metals; antimonial or medicinal Cups are made by Chymistry. I wish *Helmont* had told his secret to us of metallick Rings that cured hemorrhoidal pains and convulsions! It also shews us how to turn Ores into Metal. It has taught us
how

how to make Gold and Silver volatile, and how to fix them, as is now practised in *Peru*, with the Silver which they mix with Quicksilver, and then call it off, by which artifice they lose nothing. Take Butter of Antimony, put it into water, then smelt it, and it becomes a Mass like Silver. Try Metals thus. Sulphur is deprived of its virtue of snatching up Metals, by adding Iron to it whilst it is calcining; and fix'd Salts do also prevent Sulphurs from making Metals volatile. Thus much for Metals.

In the *Art of War* what improvements has not Chymistry made! view Gunpowder invented by *Bacon*, improv'd by *Schwartz*, and communicated to the *Venetians*, further advanced by *Coeborn*, with Nitre, Sulphur, and the Lees of Wine calcin'd. See chymical Oils mixt with double Spirit of Nitre, and Balsam of Sulphur in a Glass on the fire, and then wonder.

In *Natural Magick* Chymistry has a large share, Magick was not always taken in an ill sense, for the *Magi* were reputed *wise men*: So *Zoroastes*, the *Persian* Kings, and the Magi of the scripture were esteemed; as to the Magi, whether they could do such strange feats as are said, I don't enquire, but that nature can effect wonderful Phænomena is certain; what would people have thought of a man that wou'd have told them 1000 years ago, he could blow up a tower at a distance? And yet we now know this to be done by art. What if at that time they should have foretold an earthquake at a certain hour? Yet now 'tis done by fresh filings of Iron and Sulphur in equal parts moistened with a little water, buried under ground; how was a young rake recalled by Phosphorus, his name being written with it at his bed's-feet, and called on by his chamber-fellow to see the wonder? See its effects in authors. How do

do two cold liquors fall into a flame in an instant with a trifling quantity of them ; what might not be done with a greater ? And how much more do they flame in the exhausted receiver ? See *Hoffman* l. 3. *Obs.* 15. how Spirit of Wine with a lighted brimstone match put into the hoghead, and stopt up, flew up, and produced strange effects ? how often do we change the colours of things contained in Glasses in a moment ? how wonderful is it to give sight to the blind in the twinkling of an eye by couching ? how tortuous is the *meatus auditorius* made to hinder too great a noise ? Take care then, that children be not too soon exposed to too much light or noise ; for unusual things move us most. The Count of *Furstenburg* asked *Zwinger* how he could separate Iron filings from those of Brass ? he presently startled the Count with holding a Load-stone to the powders mix'd, and the Iron followed ; natural Magick then is not to be reputed Witchcraft, but the result of the natural properties of Bodies.

In *Cookery* it is also of great use, instructing to do every thing that appertains to that art ; how serviceable is *Glauber's* method of preserving meats from smelling, or of restoring them after they do smell, which is of great use to all Sailors, namely, his Spirit of Salt. He shews us out of malt and wheaten flower to make biscuits that will last uncorrupted for ever ; and Mr. *Boyle* shews us how to preserve flesh, eggs, &c. from spoiling.

In *making winy Liquors*, Chymistry lends its hand, as also in mending their faults, Vinegars, Cyders, Perrys, Elder-wine, and all others are made by this art, and the Cyder of *England* does not yield to the Wines in *France*, *Spain* or *Italy*. We seldom make any other here than Elder,
+ Goose-

Gooseberry, or Curran-wine : Who but the Chymist teaches to preserve wines from fermenting anew, by a Sulphur match ; or to take off its acerbity by burnt lees of wine ? or to abate its acidity, by crab's-eyes or chalk ? or to take off the crudities of Rhenishes by Ceruss, which however occasions Palsies ?

In making *Ale* or *Beer* ; what has been said of wines, may be affirmed of *Beers* which Chymistry has taught us, which is so ancient, that *Tacitus* says the *Germans* made wine of corrupted barley : Thus have I shewed the use of Chymistry in most arts ; and if all artists were skilled in it, and would publish their knowledge, how great an improvement should we advance to ?

Beyond all, the Alchymists have view'd nature ; they can't create a mustard-seed, v. g. but they have applied themselves to understand the properties of Bodies ; they have observed some Bodies to have no plastick or seminal power, and therefore don't they multiply or encrease ; such are fire, water, and the earth ; as also fossiles have no seminal power, yet they receive a nourishment that propagates them ; that there is a *Spiritus Rector* in dissolv'd metals ; and a male and a female, and have shewed how to increase them ; Silver with them is the female, Gold the male ; they plac'd a prolifick virtue in fire, and taught how to get the Philosophers Stone ; they speak darkly, but plain in many places, and I have learned many things from them ; I accuse my ignorance, not their vanity ; if the study of them enriches our understandings, we gain by the bargain. Their inventions are the Philosophers Stone, by turning somewhat mercurial into Gold, an art to turn all baser Metals into Silver ; to turn Gold into the Philosophers Stone ; an art to make an universal Medicine that would render Bodies the most perfect

fect in their kind ; how to make Gems like Fossiles ; how far it is true that Quicksilver can be ripened into Gold, or one Metal transmuted into another, cannot be defin'd : *Bacon* imitated Thunder and Lightning, and *Schwarts* improved it ; who then can tell what may be done ?

Of the CHYMICAL INSTRUMENTS.

They are Gold, Fire, Mercury, Lead, Iron, Antimony, Nitre, a Smelting-pot, a Retort and Receiver, Furnaces and Bellows, Filtring-paper, Glass Eggs, and the *Athanas* ; how can we, v. g. extract the whole taste of Wormwood without fire ? We refer the Instruments to six things, viz. Fire, Water, Air, Earth, Menstrua, and the Tools.

Of FIRE.

It has been ador'd as a God, Chymists are called Philosophers by Fire, and its effects are so wonderful, yet its substance so inscrutable, that it may be esteemed a Spirit, and not a Body. We must entertain no speculations concerning it ; we must admit of facts, or natural Philosophy will prove greatly fallacious ; we must, like the Geometers, admit of no Hypothesis, but allow things as unknown or known as they appear by trials ; for as the elements of Fire are even in the Air itself, as well as in all other Bodies, 'tis hard to say, whether most Phenomena depend not on its action ; many errors having been entertained on its effects, let us suppose that we know nothing at all of it : We know whether fire be or be not in any place, tho' we know not its nature ; as we know not what Thunder is, but when we name it, we know what is understood by the

word. This (1) sign or word must be determined to denote one, and not many things; and this word must be so individual, as never to want its *sign*; and this sign must appear to our senses, so as to discover its increase and decrease; if these three circumstances concur, we may use the *word* Fire; and if they do, we may proceed to make experiments to discover its presence, and that we do by examining its properties: In this lies the difficulty, how to discover that a Body, the coldest of any, as ice, contains fire, where there was no sign of it, but the contrary; I find *Heat, Light, Colour, Rarefaction* of Liquids, *Combustion, Fusion, &c.* to denote Fire.

Wherefore let us consider these in order; *Heat* is the first property of fire, but that does not determine the quantity of fire; suppose by the reflection of a cloud, the Sun be excessively hot, then follow Thunders and Lightning, with Showers and Hail; but these don't ensue, unless a great coldness succeed this heat; yet in this cold air there is then so much heat, that if it come upon us in a frost, it would kill us; and if a chamber were so far heated in frosty weather, entering into it would destroy us.

Light is the child of Heat; 'tis said, The more light there is, the more fire there is: but heat may be without it; so Iron heated will burn,

(1) Here is a piece of Logick to little purpose. A sign is, *that which, besides the species it imprints on our senses, causes somewhat else to come into our minds*; thus the *image* of Cesar is a sign of Cesar, because it imprints in our eyes his image, so that we *think* of him; so the word *stone* is a sign of a stone, because the name *stone* is heard, and makes us *think* of a stone; so the word *fire* is a sign of fire, because by *hearing* fire named we *think* of fire; so heat is a sign of fire imprinted on our *Bodies*, and raises an *idea* of fire. But why this metaphysical learning in a chymical treatise?

yet in the dark you shan't see it ; the rays of the Moon collected in a *lens* gave great light, but no fire appeared, by darting it upon a Thermometer, as *Hook* says ; in the focus of *Villett's* Glass there is no image of light, yet there is a fatal fire.

If fire may be without light, *colours* must not denote fire.

The more we search into its nature, the more difficulties we meet with ; if it attenuates some Bodies, it unites others, let us then see whether there be no proper sign to discover it by ; now rarefaction is a sign so proper to fire, that it may be called *proprium quarto modo, sc. omni, soli, & semper* ; and this *rarefaction* is generally in a reciprocal proportion to the densities of Bodies ; so that the lightest rarefy the soonest on the fire.

E X P E R I M E N T S.

Fire expands the hardest Bodies into all their dimensions, so long as it is in them ; so a Cylinder of Iron which fitted a ring when cold, won't pass through when 'tis heated, till it cools again ; take two rods of equal length, put one in the fire, it grows longer than the other, and shortens every moment, till becoming quite cold, it is of the same length with the other ; to determine this exactly (*See Plate 1. Fig. 1.*) Take the body *AB* of Brass or Iron, heat it, lay it down again near the other *C. D.* and you will see the distance ; or take a Brass-Rule (*AB*) *Fig. 3.* let the base *AB* be moveable, and the *Normal B* be divided into degrees, heat it and lift it up, and the degrees on *B C* shew its difference. This dilatation is constant and general. I observe that the denser are least rarefied. I find that Glass which requires the strongest flame to melt it, is least expanded ; hence in Thermometers themselves we

D 2

must

must observe what sort of Glafs they are made of ; I try'd one Thermometer with Quicksilver, and another filled with Alcohol, which agree, if the Glafs they are made with be the same.

This expansion encreases according to the quantity of fire received into the Body ; I advise the trying the length of Iron in the coldest Winter, and the hottest Fire, and then we shall exactly know the degrees of expansion.

Assoon as Iron has received the utmost heat, it expands no more ; but if by a strong Lens the fire were encreased, then would it expand more ; hence all the parts of a Body are agitated in the fire from its Centre to the Circumference, and do rarefy gradually till the Body melts ; so that all parts, even of the hardest Bodies, are changed by the softest agent, and expanded till they melt. Whether the fire divides bodies into their elements, or mixes them intimately, I know not ; but if one grain of Gold be melted with 100,000 of Silver, we find Gold in every part of this Silver.

The parts of Metals when melted, do attract each other, because they all are globular like Mercury, when the violence of the fire is removed.

Let two pieces of Metal be taken, you can never unite them till they are melted ; does fire then act on the intimate nature of Bodies ?

Who wonders then how houses newly built tremble without a puff of wind ?

Hence in the Torrid Zone, Bodies are larger and lighter ; hence *Pendulums* go slower there.

Hence is it plain, that fire relaxes all Bodies, considered as to its own action, and making humours rigid and stiff, is only an evaporation of the watry parts.

E X P E R I M E N T II.

Cold contracts Bodies in all their dimensions.

1. The hardest Bodies whatever are subject to this law, whether Silver, Gold or Diamonds.

2. And this Condensation encreases with the cold; and in circular Bodies they are straitned towards the centre; so that spherical Glasses being full, will run over, if they are plung'd into cold liquors.

3. We can't tell how far this Condensation would happen supposing an absolute coldness, but the absolute gravity is the same, whilst the specifick encreases.

4. The end of cold is rest, but of fire agitation of parts; Bodies are cold in their own nature; whether fire and cold act on the whole substance, or rest makes cold, or cold is when there is no fire?

5. Pendulums go faster near the Poles, because they are denser there; perhaps the heat makes the Equator higher, and cold depresses the Pole.

6. It adds strength, firmness and a stronger cohesion to Bodies; hence by meditating on Bodies, we may find, that they are compounded of minute parts united; whether these component parts can be further divided I dispute not, but they can grow much larger; thus *Democritus's* Atoms are understood.

7. The vicissitude of heat and cold causes a perpetual agitation of Bodies.

8. There is so great a Succussion of these two, that the air now hot becomes cold again; the Sun heats us in summer, we are cool'd again in winter.

9. The Sun, if it always heated us, would parch us; if 'twere always cold, all would wither.

10. Therefore God has made various seasons, that things might be always in motion.

11. We cannot determine the utmost degree of cold, nor of heat, both may be encreased far beyond our conception; how may fire be encreased by Glasses or otherwise?

12. We can only speak of comparative heat and cold; that is, as we find it with us.

13. It will be sufficient to us, if we can measure the degrees of heat and cold.

E X P E R I M E N T III.

The Air is expanded with the least degree of heat, as Mr. Boyle has largely proved.

This is evidently proved by *Drebbel's Thermometer*; the least breath makes the liquor ascend and descend, and it may be made so large, as to shew the least change of heat; let a large Glass *AB*, *Fig. 2. Pl. 2* have a small neck as *EF*, open at *F*; put *F* into ting'd water, heat the Ball *A, B, C, D*, the air bubbles thro' *F* into the water; abate the heat, the liquor mounts up again into the middle of *E F*, and leaps up and down as the heat abates or encreases; I like it with two Segments best, *v. Fig. 1, 2, 3. Plate 2.*

Cor. 1. The utmost expansion is indeterminable; for heat a spherical Glass till 'tis near melting, and seal it hermetically, plunge it under water, and break off its end, some air still remains in it; for it does not fill up, the air resisting its entrance, till by degrees the air mingles and exhales; so that the fire rarefies the air, but does not quite expel it.

Cor. 2. A great heat rarefies Iron but little, but a little one expands the air vastly.

Cor. 3. Increase the segments of *Drebbel's Thermometer*, and make the Tube strait and long, and
you

you may nicely distinguish any minute difference of rarefaction.

Cor. 4. The greatest degree of natural heat in the air, rarely reaches 90 degrees in *Farenheit's* Thermometer, but *Drebbel's* is easy and useful, if at the same time we mind the air's weight by the Barometer, for so you nicely discover the minutest increases of it.

Cor. 5. It is plain then, that the air is always moving, whether unconfin'd or shut up, since its rarefaction and weight are always varying.

E X P E R I M E N T IV.

The air contracts by cold in all its parts, as appears whenever heat is removed.

Cor. 1. 'Tis impossible to determine the *ultimum minimum* of the air's Condensation, because we can't banish fire entirely.

Cor. 2. The least decrease of heat condenses the air more than the intensest cold ; hence the air discovers the degree of fire.

Cor. 3. Hence every the least decrease of fire, or increase of cold, may be made visible.

Cor. 4. Hence the use of the aerial Thermometer will appear both by freezing mixtures and the winter's cold ; in *Iceland* 1709 the liquor stood at 1, and 1730 at 5 in our physick garden ; and by freezing compositions, Salt-armoniac put into a glass along with Salt, and cork'd up, were put into water and expos'd all night, the Thermometer was then at 53° above 0 ; I put in fresh powder of Salt-armoniack, and stirr'd, the Glass settled presently to 25 ; the degree of heat was then 51 ; Salt-armoniac then, one to three of water, made the cold encrease 28 degrees : The cooler the air is, the easier it is to freeze Bodies ; at 32° it is easy, not so at 60° ; when water is brought

to be so cold as to settle the Glass to 32, more Salt-armoniac settles it 4°; and by still adding more to it, we at last freeze it, and create a greater coldness than our country ever afforded.

'Tis difficult to determine the point of freezing, but if we hang a Thermometer, so as to touch nothing, I observe a wet cloth exposed grows stiff, when the Glass stands at 33°.

A Hoar is a beginning frost, and is first observed on bridges, which hang in the air and touch nothing, and therefore do best shew the temperature of the air; and as the frost begins there, it also thaws there first; other Bodies freeze not till they are thoroughly cooled.

The greatest cold, produced naturally, settles the Glass to 0°; and artificially produced to 4° or 3°, but *Farenheit*, in 1729, wrote me somewhat wonderful, to wit, that Spirit of Nitre which was to water as 1409 to 1000 warm to 48, being poured upon powder'd ice, settled the Glass to 4 under 0°; and a mercurial instead of alcoholick Glass, it settled from 16 above 0 to 14 under it, and by pouring the old out, and adding fresh to 29, and even at last to 40 under 0; Spirit of Salt cold to 17° poured on powder'd ice, settled the Glass to 8 below 0, and by pouring out that, and putting in more to the remaining ice to 14½ below 0; nay, Pot-ashes mixed with the ice, settled the Glass to 8 below 0; Mercury in this Glass then was reduced to a bulk very small, so as to approach near to Gold, since from 40 below 0, to 600° when it boils it must suffer a Condensation equal to 640 of 10782, or 69½ of its bulk: And how far cold can contract Bodies can't be defin'd.

Cor. 5. The air, free or shut up, is never at rest.

E X P E R I M E N T V.

Rectified Spirit of Wine expands in its whole bulk every where, as appears in a Glass Bubble containing 1933 parts, ending in a Cylinder that contained 96 parts; this Glass in the cold place of the earth to $N^{\circ} 1^{\circ}$, and with a warm hand it expands to 96.

Cor. 1. Supposing the capacity of the Glass continued the same (for surely it was dilated) the liquor expanded to $\frac{1}{20}$ part of its bulk.

Cor. 2. If the contraction of the Glass by the utmost cold, and its dilatation by the heat of the hand were known, then the expansion might be nicely known.

Cor. 3. How does this weight differ at the Poles and the Equator? hence again we prove the earth spheroidal.

Cor. 4. Vessels that are not full in Winter, will be full in Summer; hence never fill your bottles quite full in Winter, lest they burst in Summer.

Cor. 5. If Spirit of Wine be near boiling, it rarefies to 174 parts in the Glass, that is $\frac{1}{11}$ part more than naturally; buying things then in Summer, makes great difference; so if it settle 40° below 0, and rise to 174° above it, that is 214 in 1933, that is, it contracts and expands to $\frac{1}{9}$ of the whole bulk.

Cor. 6. If the Spirit boil, you cannot observe its degree of rarefaction.

Cor. 7. Spirit of Wine never rests in the same state, but is always, open or shut up, condensing and rarefying, and the same happens to it in our vessels.

E X P E

E X P E R I M E N T VI.

The ethereal Oil of Turpentine is expanded every way by the least heat.

If Oil of Turpentine be put into water, this plainly appears, for it rises as the water heats; and when the water boils, the oil rises no higher, encrease the fire to what degree you please; for once water boils it can be no hotter; however the heat of boiling water encreases as the air is heavier, and *vice versa*; thus *Monf. des Amonton* and *Farenheit*. From hence is it, that the heat of the Sun is greater when the air is heaviest on the surface of the earth, *v. g.* and least when it is less, as on mountains, &c. Thus heated water boils in the exhausted receiver sooner. In *Papin's* digester let water boil, the water expands to $\frac{1}{85}$, and air to $\frac{1}{3}$; the water is 30° hotter from the pressure only; oil at 52° , when boiling at 212° . *v. Cor. 2. Exp. 5.* Alcohol boils sooner and oil of turpentine later than water, tho' lighter, either from some affinity, weight or tenacity.

E X P E R I M E N T VII.

Rain-water heated gradually, rarefies gradually; for it rises from 56° to 212° , and then it boils.

E X P E R I M E N T VIII.

Quicksilver easily rarefies with heat; it rises to 212° in *Farenheit's* Thermometer.

Cor. 1. A Lixivium of Sea-salt, Salt-petre, fix'd Salts, all Liquors, Air, Oils, Water, Saline Spirit, Oil of Vitriol and Mercury, are all subject to this law.

Cor. 2. This cause passes thro' all vessels.

Cor. 3. This cause is heat or fire.

SCHOLIUM.

This cause where-ever it is, has two properties, to wit, it penetrates and dilates.

EXPERIMENT IX.

Put one piece of Iron upon another, rub them together, they grow hot, sparkle and become fire.

Cor. 1. This experiment answers in all weathers, and soonest *cæteris paribus* in cold weather.

Cor. 2. It answers also in all places, but soonest in dry places.

Cor. 3. In *Vacuum* Bodies by attrition grow hot, as *Hawkesby* and *Gravesande* shew.

Cor. 4. Fire produced this way does, as all other fire does, *viz.* penetrates, heats, expands, burns, &c.

Cor. 5. The harder bodies are that are rubbed together, the sooner do they fire, and the greater is the heat; the softer the bodies are, the longer ere they take fire, if they do at all: Iron cool'd in Summers Air is softer than when dipp'd in water; thus the axle-tree of a mill, if greas'd or lin'd with Lead, won't fire. A Hone oil'd won't fire with the razor, but will heat if rubb'd together; the hardest and densest Bodies then fire the soonest; this even holds in wood, as appears in the *Sideroxylon* (Iron-wood) of the *Indians*, which serves them for Arms, and fire also by attrition. This holds in Steel and Flint.

Cor. 6. The weight alone of two pieces of Iron laid upon each other produces no heat; but the greater the weight and the velocity of attrition are, the sooner is fire kindled; a small velocity of attrition produces only a warmth, but a brisk motion added to the weight, soon fires.

Cor. 7. A

Cor. 7. A flow motion of a rope does not heat the hand, but draw it through with force, and it will burn ; so a file with Iron strongly mov'd backward and forwards, heats, so does a knife on a hone ; velocity then produces the fire.

Cor. 8. Hence if weight, hardness and velocity concur, fire may be encreased infinitely.

E X P E R I M E N T X.

If any Liquid be interposed between two surfaces, little or no heat ensues ; put a little oil between the razor and whetstone it never heats, which without that it wou'd ; the same in Mills greas'd ; so happens it in grinding Glafs with oil or water.

Cor. 1. Hence smooth and soft Bodies are unapt to heat.

Cor. 2. The less Bodies are pressed together in rubbing, the less heat is produced.

Cor. 3. If other properties concur, but strong friction be wanting, there is no heat.

Cor. 4. Hence if there be large spaces in Bodies, and they cohere slenderly, fire is not made sensible to us. *2dly*, Or if there be no friction. *3dly*, Or if no other cause concur to make motion in the spaces : In the *vacuum* at the top of the Barometer such is the case. Shake this Tube in the dark, light (which is a sign of fire) appears, but no heat : At the tops of high mountains Snows lie all the year ; the higher then, the less motion is there, and less heat. The Alchymists have said, that in pure fire there is silence, rest, and God dwells there ; so said the *Hebræans*, *Exod. iii. Ps. civ. Epist. to the Heb. i. 12.*

Cor. 5. The sudden heat of Metals appears by various examples ; so a bullet thrown 600 feet in a second, which motion is more rapid than a storm, when it falls, is very hot, which depends on

on the friction of the air, not the powder. This confirms what is said above: So that altho' the Weather-glass with Spirit settle to o, yet there is heat in the air.

If you expose Bodies of all kinds, Metals, Oils, Spirits, &c. to the air, they are equally cool, and if you apply the Thermometer to them, and the *vacuum* of the Barometer, you will find them all equally hot.

I could never discover any space void of fire, and 'tis equally dispersed thro' all Bodies, unless causes concur; I never found any magnet for fire, to unite, in any centre: However Iron may feel to us cooler than Feathers, it is not so in fact.

When all things keep their forms and shapes, and heat is equally distributed every where, nobody thinks of heat; but when, v. g. wax melts, then fire appears.

Where-ever fire is, there is motion, how little soever it appears to us; who is he that can assign absolute cold, or a perfect rest in fire? If ever fire encreases, it rarefies; there is a principle in Bodies of attraction and of repulsion; Bodies would stronger attract each other, if fire did not hinder. This is seen in Quicksilver settling and contracting itself in Winter, and dilating in Summer; the first is caused by its attractive force removing all heat, the latter by the repelling and rarefying force of heat.

Fire does not penetrate Bodies, it only enters the pores, for Bodies are impenetrable; this *impenetrability* is called *Αντιρρησία* Democriti.

So long as fire lodges in these pores, and has a free entrance and egress, no effects are observ'd; the puff of a pair of bellows don't settle the Thermometer, therefore neither heat or cold are increased by this wind, for this don't disturb the air; but if the whole air were disturb'd, then
heat

heat would ensue ; why then does this blast cool us ? Don't we find cold so troublesome as to cause gangrenes ? But the case is otherwise, nobody can live in air heated to 90 degrees, but our own heat is equal to 92, and in children to 94 ; hence we are always hotter than the air ; hence our cloaths are warmer than if exposed to the air, and we warm the air around us ; if the air then is calm, we are warmer than it ; and if a cold air comes, we grow cold ; the air and our cloaths are cool'd, as if we put on cold ; so that tho' the wind don't produce cold, yet it cools us : This remark is of use in physick ; for let a person be hot to 100 degrees, the air be 48° hot, the cloaths will be hot as 100 ; and the air near us hotter than to 48° ; for a man entring alters the Thermometer, which settles again upon his retiring ; let the air in this supposition be 60° , then our body is surrounded with this temperature of the air ; if the body be exposed to a wind that moves 6 foot in a second, then all the warmth of our cloaths will be reduced to 48° , then we grow cooler by 12 ; and if this continues, we grow cooler every moment ; hence does the reason of this Phænomenon appear.

Let therefore any wind ever so strong blow, if no other cause concur, the Thermometer never alters ; if then, we being over-heated, expose ourselves suddenly to the air, or if weakly persons overheated in their chambers, let in a colder air suddenly at a chink, what mischiefs don't ensue ? Asthmas, Pleurifies, &c.

We may now contemplate on the nature and action of fire ; if two hard and heavy Bodies are rubbed together with great celerity, there arises a vibration, *sc.* Contraction and expansion, as in musical strings and bells, thro' the whole mass, and all its component parts, from whence all the
noise

noise arises ; and as all this arises from attrition and agitation of the most elastick body, wherever that is, fire will appear ; where it is not, there the body is all over of the same heat ; wherever attrition is increased, the fire increases.

Why do elasticks only produce fire ? because they only vibrate : Why do the most elastick Bodies fire the most ? because their vibrations are swiftest : Why do soft and non-elastick Bodies produce less fire ? because they don't vibrate : Why does lead heat upon attrition ? because its component parts are elastick, altho' the compound is not. Don't fluids generate heat ? yes, if elastick, hardly otherwise ; waters hardly heat, yet as their elements are elastick, they heat by violent motion : if the tubes they are conveyed thro' be elastick, they heat the sooner ; but if the tubes and liquors are elastick too, they heat and continue hot ; this is the case of the blood, which the more watery, the less hot is it. Why is heat hindered by the intervention of a liquid ? because soft Bodies elude friction. Does elasticity then augment heat ? yes, greatly. If attraction did not determine Bodies to contract, what would become of fire ? then fire would not appear, as in mountains and mines. What happens in deep fountains, where the air is at rest ? there the heat is always equal, as is confirmed in the observatory at *Paris*. Why does Flint and Steel give the liveliest sparks in Winter ? Gravity, Elasticity and Fire are three universal things, or common causes of actions in Bodies, to which if you add attrition, this question is answered.

Bodies the heaviest at the centre of the earth, rubb'd strongly together, would raise a strong fire ; hence it is, that this appearance is greatest at the centre, and least betwixt any Star and the
Earth,

Earth, because fire is least where there is no resistance.

If the pores of a Body are so large as to admit Oil, Spirits, &c. then these Bodies don't heat, but if they are so strait as to admit nothing but fire, then they heat ; or if two Bodies are polish'd and fitted, or if they are agitated so quickly that nothing can enter but fire, or if the elements of a Body are elastick and strongly knit together ; in all these cases, fire will take place.

I have often thought whether any Bodies attracted fire more than others, and I only find that rarer Bodies take fire soonest, and densest are longer in cooling.

Percussion attracts fire, and makes Iron hot so as to fire Brimstone, because this force shakes the inmost parts of the Body, and raises a tremulous motion in them.

This heat is only raised by compression, attrition and vibration.

'Tis elasticity that causes these vibrations, and their continuance.

It may be asked whether the fire rais'd pre-existed in the Body ; I say it does, and 'tis only percussion that makes it more evident and active.

It appears then, that in the utmost known cold, fire resides, which penetrates all things, and expands all things but space.

E X P E R I M E N T XI.

Fire known by its rarefactive, motive, and penetrating power, collected in any space, moves and expands itself every way from the centre of that space or body : As a proof of this, a lead or bullet plung'd into warm water, till it is as hot as it, and a red-hot poker, move the Thermometer

mometer equally with the water and fire they were heated in, each at the same distance.

Cor. 1. Hence fire tends to all points indifferently ; a little sphere (of fire) placed in the centre of a larger, expands it self around, so does it in the air (*m*) and this idea differs little from the idea of rest.

Cor. 2. Let a small Globe of air *A*, *Pl. 3. Fig. 1.* be hotter than that in *B*, then I say that the expansive force will be as the spaces of the parts placed around, to the whole circumscrib'd space.

Cor. 3. Suppose a circle *A*, *Pl. 3. Fig. 2.* full of fire, touch'd by another *B*, draw Tangents *CD*, *CE*, to *B* from *A* ; it is plain then, that the fire of *A* can't come to *B* but from the Sector *FG*, whose geometrical proportion to the whole Globe *A* is easily found, as also the magnitude of the Cone *C, D, E* ; and of the Segment *D, I, E* ; hence the quantity communicated may be had.

Suppose then by any physical cause, all the fire in this sphere should be driven directly in parallel lines towards another part, its whole force will be so united, as that it will pass from the Cylinder, *Pl. 3. Fig. 3. E, F, G, I*, to the Globe *K, G, I, B* intirely ; so that the latter will be to the former, as the whole to a part, and as the parallel direction to the diverging one ; but from the effect of combin'd causes, there will be produced a force greater than the former. But the force of the fire augmented to double, increases the efficacy prodigiously ; for at 32° it freezes, at 64° the air

(*m*) Pray where do you place the fire but in the centre ? And are not all qualities whatever intended or remitted in a reciprocal duplicate proportion from the radiating point ? What is the Sun, but this point from whence all heat is dispers'd ? They then who are twice as near the Sun as we are, will be four times hotter, *ceteris paribus*.

is very hot ; at 96° the air is fatal to animals ; at 216° , that is when 'tis hotter than boiling water, it destroys all animals. Since then the air of the greatest circle in this sphere is to the whole surface of the same as 1 to 4 ; the fire in the Base of the said Cylinder being four times compacter, than in the surface of the sphere, hence the fire will be more united and increased. If then it could be accurately known, how much the force of the fire to be expanded is increased, in proportion to the lesser spaces into which it is condens'd, the rest may be had. Suppose it were as the area's, the force would be quadruply greater from the quantity ; quadruply greater from the expansion ; and therefore it would be sixteen times greater from both. We should try then by experiments, whether the expansive force of the fire with respect to its density could be determined. It is likely that this is very great in the fire ; and therefore this parallel direction is the greatest.

E X P E R I M E N T XII.

The Sun (1343 greater than the earth, and distant from us 12543 diameters of the same) darts its rays in a parallel direction, as all know, if nothing hinders it ; and from the point of inflexion the rays run parallel again ; this experiment proves it : In a fine winter's night at midnight, the Moon and all the Stars are lighted, nothing but the space of the earth is shadowed ; let the Sun's rays in at a hole in a darkened chamber, the light is not seen but within the cone of rays.

This is confirm'd, because the Sun's rays fall directly on Bodies as it rises and sets ; so does it when reflected from Glasses ; and in Optics 'tis taught, that

that the rays of the Sun falling directly upon a Glass, are reflected in a direct line to another; and in this supposition their *Calculus* answers so accurately, that the Phænomena answer to their demonstrations.

This parallelism causes heat in Bodies, and so it is whether we speak of heat or fire; so that this direction increases the expansive force without any emission of fire from the body of the Sun.

But you will say, Why then does not a candle heat a place? I answer, Because it is diffused around, and unless you hold a body near it, this direction is lost.

Cor. 1. As soon as this direction ceases, the fire and heat cease; for then the rays are darted equally round, and if you put any body between the Sun and *Villett's* Focus, no heat ensues.

The windows of *hot-houses* for plants should be made to the south; they should be erected from the pavement to an angle of $14^{\circ} 30'$, and the ceiling in the latitude of $52^{\circ} \frac{1}{2}$ should be so made, as to decline from a horizontal line from the windows drawn from the height of the lights towards the back wall, about an angle of $20^{\circ} 30'$; for if the ceilings are not illuminated, the place is cold, and perishes the plants (*n*).

Cor. 2. The heat produced by the Sun any where is much less than our native heat; for our heat mounts the Thermometer to 92° , but the Sun's only to 48° . I speak of heat without reflexion; for clouds reflect greatly, but never so as to set fire to Alcohol, Gunpowder, Sulphur, &c. I abstract from lightening: So that attrition produces greater heat than the Sun; we can't say

(*n*) As to the construction of winter or hot-houses, consult Gardeners.

'tis hot because it is sun-shine ; for Iron will fire Gunpowder, though it don't shine ; heat and light may be separated.

Cor. 3. The Sun's heat therefore never destroys any, unless by reflexion, as at *Ormus* it sometimes happens from the mountains of white-salt.

Cor. 4. If the Sun should shine at a time when all things are disposed to an equal transmission of its rays, then would it act in parallel lines, but that seldom happens ; hence its vicissitudes of heat and cold.

Cor. 5. Hence heat is seldom found the same in different places, by reason of these impediments of equal transmission.

E X P E R I M E N T XIII.

If the heat of the Sun falls upon black colours, they retain the heat longest ; they sooner heat, and sooner dry, when wetted ; the more bright colours are, the more they reflect the light, and heat less ; hence white are best to wear in hot countries ; white heat least, but dry latest. I have long known that black Bodies burn soonest ; all natural history confirms that white wood, linen, paper, white-earth, burn slowly, but the blacks very quickly ; this is true, if Gunpowder, &c. and black clouds breed thunder (o).

E X P E R I M E N T XIV.

Black things do not reflect a fiery heat ; so smoak any burning-glass, even *Tschirnbaue's*, and it burns nothing ; blacks are privations of colours, blacks are best for sore eyes ; how small a matter then hinders the Sun's heat ! any black crust hinders it, whereas white things reflect the heat strongly, as a speculum of Silver, or Glass silvered behind. Gold reflects

reflects strongly, so does wood hollowed accurately; nay, even a speculum made of Straw finely wrought, burns strongly; other colours may be tryed according to *Newton's* stated laws of colours.

Cor. 1. The colours of Glasses make the fire stronger or weaker.

Cor. 2. We may know what effect heat will have upon Bodies; black earth burns the feet, and spares the eyes, and the white earth cools the feet and hurts the eyes; umbrells may be made warm or cool, so may houses, huts, &c.

Cor. 3. The Sun is hottest where the earth is black; and in *Ormus* and *Gamron*, the white mountains make it impossible to live but under water all but the head (*p*).

Cor. 4. The fire makes water to mount into the air, and the lighter the air is, the easier it rises; when it is come high into the air, it condenses into clouds, which reflect the Sun, and make the air hot; if the clouds are black it breeds Thunder.

Cor. 5. We see then the reasons of the sudden vicissitudes of heat and cold; where-ever the Sun's rays are parallel, it is hot, and *vice versa*.

E X P E R I M E N T XV.

Suppose the Sun's rays were received upon a white body finely polished, and so reflected from it as to be all united into a point, then would fire be all collected into that point.

So much stronger will the rays be in this point or focus from their quantity united, as the place uniting these rays is less than the sum of the space of the surfaces of the reflecting Bodies.

If by art, a parabolick Speculum could be made, dense as Gold, white as Quicksilver, and

E 3

elastick

(*p*) Hence dangerous fevers happen to our sailors.

elastick as Steel, and the open of the basis large, the whole force of the fire would be united in a point.

Or if the speculum were made spherical, of solid, white, hard, elastick matter, without rasures, the fire would be very violent.

To mention no other, I shall only speak of *Villett's* Glass of *Lyons*; who made a Glass of a certain mixture of metals, which is concave on one side, and convex on the other; its diameter is 40 inches over, and therefore its area is 1452 $\frac{1}{4}$ inches, when the rays are admitted; 'tis finely polished on both sides; it weighs 400 lb. *French*; the rays are collected into half an inch; its focus is $3\frac{1}{2}$ feet distant: So that the rays are collected from 7369 of a circle into one; hence in the focus there will be 7369 times more fire here, than in the air from the Sun.

This difference is great; but I have suppos'd all the rays to be reflected, which is not true; for there are rasures to be seen by looking obliquely on the Glass, which distort many rays; so that this computation must be abated: In the focus of this Glass branches of green wood flam'd immediately, metals and semi-metals melt in an instant, bricks and every thing melt instantly into Glass.

The cooler is this speculum, the sooner it burns; so that its effect is stronger in winter; heat widens the pores of it, and lessens its elasticity. It being exposed to the Moon at full, gave a vast light, but no heat to the Thermometer, and yet it burns vehemently all things when expos'd to the Sun; therefore fire and light differ: This disadvantage attends it, that you can't hinder the melted Bodies from falling down, and you are hindred thereby from farther tryals on them; however

however it is so finely polished, that it reflects better than Glass quicksilver'd.

Cor. 1. The Sun only gives heat and not the Planets; they may give light, but nothing besides; so that astrology is vain and ridiculous from heat.

Cor. 2. Whatever changes we suffer from the fix'd stars or others, must depend upon gravity, or attractions and repelling forces, which are not determinable.

Cor. 3. We may pronounce on Phænomena, to wit, water is snatched up into the air, it mounts high, as the clearness of the weather and the air's weight prove; it freezes there, appears in clouds: From the Sun's reflexion greater light is produced, sometimes darkness; when they shine, it is a sign of frost or snow; in hot weather they mount high, fly about, and are white, and presently they grow heavy, dark, and full of rain; if it falls in great drops as in summer, it is a sign the clouds were hail thaw'd; the higher clouds fly, the more their matter cools, and even freezes; and the fiercer is their fall, from their altitude which accelerates their fall; hence a small cloud on high in *Asia* falling, makes the *Ox-eye* or Whirlwind; white clouds are snow, and the Sun reflected from them heats; the part they shade must be cold, because the earth is shaded; it can't then, Gentlemen, be any surprize to see the various changes of seasons, how great heats are succeeded by great storms; for suppose the clouds reflect the Sun, there must be a reflecting speculum; this being inverted, great cold and storms arise, if by the force of gravity air runs into the Barometer at the rate of 22 or 23 feet in a second; what may not happen by such specula? And thus may all vicissitudes be understood.

Cor. 4. Hence thunders, storms and the like happen after frost, because the vapours are lifted up into the air by the succeeding thaw and heat.

Cor. 5. The rays of the Sun reflected from the ground, houses or mountains, in some places do raise heat; colours do also change the heat, so do seasons of the year; hence heat differs according to those circumstances, some morning, some evening Suns are warmest; let us examine these things, which may vary according to the reflexion; hence valleys are hotter than plains; cattle are cool in heaths, for they are thorow-blown, unless from reflecting clouds it should chance to be hot; hence heat is equal every where at like distance, if no other cause concur.

Cor. 6. One word more; meteors owe their rise to various reflexions of the Sun's parallelism.

Cor. 7. It would be of use, if we knew the proportion betwixt the quantity of inciding and reflected light; light falling from a diameter of two feet on a spherical concave, and reflected into a focus of an inch diameter, the magnitudes of this area and focus collecting the rays are in a duplicate *ratio* of the diameters; hence rays inciding to reflected rays are in that proportion; but others who considered things physically were puzzled to know this problem.

A great many rays that should be reflected, are drowned in the pores of the reflecting body; for no matter yet used can be free of rasures, because nothing heavier than steel has yet been used for that purpose.

Suppose you could make your speculum spherical and solid, it would appear black every where but in the focus; but you can't polish without rasures, as you may see by a microscope.

But

But suppose we get over this difficulty of polishing, light is so heterogeneous, that some rays might not, nor could they be reflected; so that you only can reckon the quantity of them, but know not what to subduct.

It is a question, whether the force of fire be as its quantity, so as a double quantity acts with a double force; for we know that a greater quantity in a less space, acts infinitely more than when dispers'd; Bodies at a distance beyond their sphere of activity, act not at all as Loadstones, which act, as Sir *Isaac Newton* suspects, in a triplicate reciprocal *ratio* of their distances, which Mr. *Musschenbroeck* Professor at *Utrecht*, labours hard to ascertain.

Suppose many Loadstones plac'd within the sphere of one, they will all move; but if one be plac'd in the centre of this sphere of attraction, how do they move, and faster as they approach? so fire collected becomes more violent; *Villett's speculum* burns all in its focus, but five inches from the focus a Thermometer is not heated to 190° ; condensation therefore, or agglomeration raises all these agitations.

It is not yet known, whether the reflecting force, where the parts of the speculum make the rays red hot, be equally strong at the axis where they incide, as about the upper part of the speculum, and therefore it may be doubted, whether all the rays reflected and uniting in the focus, do so unite, as that the force united answers to the number of rays collected.

By covering any part of the speculum, we can intercept any number of rays, and so lessen their force; hence if we cover half, we may compute how far the force is lessened, and whether that depends on the number of rays or any other law.

Cor. 8. Suppose we cover the Glass, so as to boil water only, and then open it so as to make the Mercury ascend to 424° , then there would be a double heat; by such comparisons we may encrease the fire infinitely, or lessen it, and compute the aperture of the Glass. Fire differs from Cold only by the action of a resisting body.

Cor. 9. The greatest heat possible vitrifies Bodies; this appears in *Villett's* speculum vitrifying flints, &c. but this is done by striking fire with a flint and a steel, the sparks are flint vitrified into globules, as you may see if you catch the sparks on paper (*q*).

E X P E R I M E N T XVI.

The rays of the Sun received on a spherical speculum, and collected into a focus, do burn violently. This is evident in *Tschirnhause's* spherical Glass, 4 feet in diameter, convex on both sides, exposed to a clear Sun at 9 or 10 in the morning, till 3 in the afternoon, the focus was 12 feet from the Glass of half an inch. It burns all combustibles, and vitrifies.

Cor. 1. The diameter of *Villett's* Glass is 43 inches; its circumference then is $9\frac{4}{7}$; of *Tschirnhause's* is 48 inches, its circumference is $10\frac{5}{7}$; the inciding rays of the latter to the former's, are as 2304 to 1849, and yet *Villett's* is stronger much.

Cor. 2. Hence it is plain, that *reflexion* does preserve the rays more untouch'd than *refraction*, by which many of them are lost.

Cor. 3. *Villette's* is $406\frac{7}{8}$ square inches; its focus is $7\frac{9}{28}$ square lines; the area of *Tschirnhause's* is $506\frac{8}{28}$ square inches, and its focus is $7\frac{1}{28}$ square lines; so that the focus of the speculum to that of the Glass is 1 to 4; hence is reflexion stronger

stronger than refraction, and opac specula are better than transparent Glasses; besides the opac specula may be made larger, the others hardly. Pity it is Princes don't encourage artificers to proceed further.

E X P E R I M E N T XVII.

Tschirnhaufe made a Lens of a less Segment, to receive all the rays, and to communicate them to the former; he reduc'd the rays from 8 square lines to 16. It burnt more than the former, but many rays were lost. I shall recite to you its effects, to shew you that gross fire is not required to do more than suffices to chymical purposes.

1. Wet branches were consumed into flames, and into ashes in an instant. 2. Water boiled instantaneously; I wish this had been try'd with *Fahrenheit's* Thermometer of mercury, to have known whether it would have made water hotter than common fires. 3. Thin metallick plates melted gradually, but solid pieces slowly. 4. Brick and Talc grew red in an instant, and then vitrified. 5. Sulphur, pitch, rosin, melted under water. 6. Wood in water seem'd outwardly sound, but tried, was a coal. 7. If the matter was on any black basis, the heat was greatly increased. 8. If the substances are plac'd on charcoal made from green wood, they sparkle and fly away; Lead and Tin soon vitrify. 9. Ashes of vegetables vitrify quickly. 10. Great things don't melt soon, but powders quickly. 11. Black things change presently, but not white ones, or such as become so; so chalk, lime, flints don't change. 12. Metals on porcelain vitrify soon, so it be heated moderately, and be so thick itself as not to melt. 13. If the matter be plac'd in a Glass-jar, so as the rays fall on the body, and not on the Glass, there

there are strange phænomena. 14. Nitre exhales instantly into spirit, which our fires can't do without earth mix'd, or oil of vitriol. 15. The Moon's rays give light but not heat. 16. It moves all Bodies even *in vacuo*. This Glas therefore is weaker than *Villette's*, but is fitter for trying fire by its effects.

Cor. 1. Water in the atmosphere, or little pieces of ice gathered into globes, as they are greater or less, and transmitting the Sun, may produce more wonderful effects than this Glas.

Cor. 2. I must remind you how the steel and flint do assoon vitrify Bodies as these Glasses, barely by attrition.

Cor. 3. There needs no Sun then, nor inflammable matter to produce the utmost effects of fire, as melting metals, &c.

Cor. 4. The Sun does not afford fire, 'tis only the direction of its rays that raises the latent fire of the body; a veil drawn before a Thermometer, or *Villette's speculum*, there's no rising of the spirit or mercury, nor any burning; draw aside the veil, and the one rises whilst the other burns vehemently.

Cor. 5. The greatest heat possible would be, if the foci of the speculum, and the glas named should so be ordered, as to fall upon the body at once, in a diametrical opposition; clouds may act so.

Cor. 6. This heat might remain, so long as these circumstances continued, and yet no pabulum afforded.

Cor. 7. Remove this circumstance, the fire, the light, heat, and all effects cease in a moment.

Cor. 8. Fire seems then to consist in the physical power of expanding itself around equally, and where that power resides, there is fire; where it is wanting, there's no fire.

EXPERIMENT XVIII.

True fire can be joined to every solid, and reside there long enough, nor does it perish as in the aforesaid fire. All Bodies exposed to fire shine and melt; this is well known; water itself, if it should be turned into earth, would shine when on fire; hence some cause must detain the fire; for that from the specula fires nothing, if it is only in the air, but perishes; but if it fall upon an iron globe, till it is set on fire, it remains, because there it falls on a solid matter (*r*).

EXPERIMENT XIX.

This elemental fire is true fire; for the Thermometer rises by the heat of hot Iron, and settles upon its removal, as you approach or retire (*s*); sulphur held to the red hot poker, as you approach it smoaks, and at last flames; and gunpowder, wood and other bodies flame with it; but alcohol exhales without flaming, which is strange.

EXPERIMENT XX.

Weight is not what sticks to the body, for Iron and Brass weighed the same when red hot, as when cold in the scales, made with metallick

(*r*) Where is the wonder, that the force impress'd on Bodies should continue, altho' the agent ceased to act? That a stone should go forward in the same direction it was thrown, altho' the person who threw it, should die the instant he delivered it? Or that a burning-glass should light a pipe of tobacco? Or that the air should disperse the fire it receives?

(*s*) Because qualities are in a *ratio* of their distance from the radiating point.

chains,

chains, lest the moisture of the ropes might lessen the weight (*t*).

Cor. 1. Fire forms a circle around it of heat, which heats as we approach it (*u*).

Cor. 2. The greatest heat is in the centre of this circle or this body.

Cor. 3. It decreases as you retire from the centre of this body ; and it vibrates all the time the fire lasts there, till it quite flies off.

Cor. 4. We can only guess at the proportion of fire by its effects ; and since we know not the proportion of its power from its condensation in respect of that from its quantity, so long we dare not argue concerning its quantity from its effects.

Cor. 5. Fire does not concrete into any corporeal mass, tho' it encreases the bulk, not so the weight.

Cor. 6. It does not lessen the weight of Bodies.

Cor. 7. It is under the form of a third thing in Bodies.

Cor. 8. There must be some cause that detains it from dispersing.

Cor. 9. Body is what retains heat, and the denser bodies are, the longer do they keep hot ; so air loses heat presently ; gold keeps longest hot : That body which is hottest retains its heat longest, the matter being the same ; oil and water boiled retain their heat according to their *pondus*,

(*t*) Pray what weight can we perceive may be added to a heated body by the particles of fire in five Pounds ? A parallelo-piped weighing five Pound, would not take up more space than $\frac{1}{6}$ of a grain of air ; and fire being lighter than air by a considerable degree, where will you find a scale that will shew us so nice a difference ?

(*u*) Qualities are intended and remitted in an inverse duplicate *ratio* of the distances, twice as near, four times as hot ; four times nearer, sixteen times hotter. *Keill. Introd.*

nor does oil keep it longer for its tenacity. Fire gives to every body only a certain degree of heat ; but when a light body boils later, it receives more than a heavier ; water is heavier than linseed-oil : Water has 213 degrees of heat when it boils, and then it can grow no hotter ; the oil which is lighter requires 600° before it boils ; Quicksilver which is 15 times heavier than this oil, requires no more fire to make it boil than the oil ; so that the *pondus* alone is not the reason of their boiling sooner or later. Water then may extinguish fire, since combustibles never burn with only 213 degrees of heat. Tin and lead melt before oil boils, but not so with water in them. Hence when fire passes freely thro' a body, so as to make it boil or melt, that body can receive no more heat. To sum up all this Corollary, a greater heat lasts longer, a denser body retains heat longer ; that heat sticks longer in oily bodies, and that they therefore contain heat in proportion more than others that boil sooner ; that the denser, the more fire they require before they grow hot with a rarer body, and therefore require a longer time to cool. We may at length by experiments be able to solve these problems, *To fill a given space with such a body, as it may grow hot to a determin'd degree with the greatest fire, and, to fill a given space with such a body, as the greatest fire possible may be retained in it.* 'Tis worth enquiry, whether Iron, being slower in melting than Gold, when it is melted, is not hotter than Gold when melted, altho' denser (x).

Cor. 10. The hotter Bodies are, the sooner they cool with applying a cold Body to them ; and

(x) This is opposite to Sir *Isaac Newton* and himself else where.

the denser is the Body into which they are plunged, they cool the sooner, *v. g.* much sooner in quicksilver than in water, in water than in air, in certain proportions ; to soften Iron extinguish it amongst the warm ashes, to harden it in water.

Three causes concur to cool Bodies, coldness, density, and stirring the body in fresh cool liquors ; so Iron hardens in cold water.

Cor. 11. The reason why denser Bodies cool heated Bodies soonest, is, *The distribution of the fire is as the bulk* ; so that if there be lbj of water boiled and another lbj of cold water, the first has 212° of heat, the latter only 32 , then $212 - 32 = 180$, and $180^{\circ} \div 2 = 90^{\circ}$ so that the heat will mount the Thermometer only to 90° ; hence the common degree of heat (30) vanishes, and the excess is halved ; but if you mix boiling water with quicksilver, there is a greater difference ; for if the water was hotter than the quicksilver, if equal bulks were mixed, then the temperature was hotter than half (as in water with water ;) on the contrary, if the quicksilver was hotter than the water, the temperature was cooler than half the difference ; and the diversity was such, as if three parts of hot water were mix'd with two of cold ; or in the latter case, as if three parts of cold water were mix'd with two of hot ; but if you take three bulks of mercury equal in extension, and two such of water, then it is equal whether you heat the quicksilver or the water, there will then arise a temperature equal to half the difference, as at first was said of the water : So that altho' quicksilver were to water as 20 to 1, yet the heat measured would be equal, if the bulks be so. These were *Fahrenheit's* experiments.

Cor. 12. Heat decays last of all at the centre ; hence how long would a great and dense Globe be a cooling ?

Cor. 13. The denser the body, the less is its surface ; the less the surface, the longer do they retain heat ; and as spheres are of the least surface of all bodies of equal perimeters, they retain heat the longest.

Cor. 14. And as bodies become of greater surfaces as they are divided, as in a sphere into many, of a cube into two equal parallelopipeds, &c. hence do these cool sooner.

Cor. 15. Hence the more solid are our fibres, the longer do we keep warm, as we see in strong men ; they keep longer warm than those of wat'ry constitutions and weak fibres.

Cor. 16. 'Tis a question, whether the blood is hottest in the heart ; but I say 'tis of an equal temper from the coldest blood of the veins, and warmest of the arteries mix'd. We can't bear too hot blood, nor too hot air. A bird, a dog and a cat were tryed in a sugar hot-house ; they all died soon, and so do the men, if they don't retire ; hence 48 times hotter than usual, will breed fatal diseases.

Cor. 17. The denser, the larger, and the more spherical bodies are, the longer do they keep hot ; moreover, the lighter is the air it contributes.

Cor. 18. Yet all bodies do soon cool in the air.

Cor. 19. Is not vibration of the elements then a cause of the fire's continuance ? The sound of a bell continues for many minutes, and even longer than we hear it, as appears by sand sprinkled on it.

E X P E R I M E N T XXI.

The denser bodies are, whether fluid or solid, the longer they are in heating; this is plain by boiling liquids, and by the Thermometer, from air up to Gold.

Cor. I. Hence bodies admitting entrance later, cool later.

E X P E R I M E N T XXII.

The greater bodies are, *cæteris paribus*, the slower they are heated. This may be looked upon as an axiom.

E X P E R I M E N T XXIII.

The denser and greater bodies are, they require more fire to heat them to the utmost heat, v. g. lbj. of Iron, a plate of it heats sooner than a sphere of it. Hence the surface is the measure of receiving and letting go the fire.

E X P E R I M E N T XXIV.

There is no body found, that will be hotter than all the rest; for if the hottest bodies rest a while in the air of the same temperature, they are reduced to the same degree of heat and cold as the rest; phosphorus is as cold as water in water; linseed oil in a frost, tho' it don't freeze, is as cold as ice in a frost; the same may be said of alcohol, mercury, spirit of nitre, steel, flint, and all others; so that no body whatever is disposed more for heat or cold, none grows hotter of its own accord than another.

. Cor. I.

Cor. 1. Has then a dense body, in heating, more fire in it? or does that greater quantity of fire compar'd, owe its heat to a greater fire applied to that body? or does a constant application of the same fire cause, that a greater quantity of fire is got to that body so heated?

Cor. 2. Whether the physical cause of the long detention of the fire in a heated body be the fire itself insinuated into the body?

Cor. 3. Or whether the cause of this detention be the body heated and the fire too?

SCHOLIUM.

Thus have I essayed several enquiries on the nature of elemental fire, and as it resides in bodies; as also its *motion or attrition*, before I treat of its nourishment; this difference Chymists hitherto have not considered. Now we come to common fire; an Iron-rod when heated is $\frac{1}{60}$ longer; a glass Cylinder a span long heated is $\frac{1}{50}$ longer; a ring of metal is $\frac{9}{1000}$ wider; a glass Globe is extended $\frac{1}{10000}$ more by the heat of the hand; a Thermometer in hot liquor descends first, then ascends; in cold, ascends first, then descends; heat expands liquors *per saltus*; mercury in a glass heated by water till it boil'd ascended gradually, therefore such a Thermometer is best; two rods of metal equally heavy, the one heated, the other cold, the hot one is lightest (*y*); if a live-coal be put under the cold one, they equiponderate; if a coal be put under, 'tis heavier, if above 'tis lighter, where there was an equilibrium before.

(y) He says otherwise before.

Of the PABULUM of FIRE.

Since it seems indisputable, that fire always exists in the same quantity unchangeable, and that it inheres in some bodies, as gold, silver, &c. without destroying them, we now come to try in what bodies it may be bred and detained long enough ; and even so encreas'd as to consume them ; till no more of these sustaining parts subsist, but have vanished.

Wherefore as soon as these parts, and the body is consumed, we say the *Pabulum* is wasted, and justly, but it wants proof to affirm, that this *Pabulum* is changed into elemental fire newly created ; and that it is encreased thereby ; for what would have ere this become of the world, if it had been so augmented ? but we have no sign of this, for it is now, as it has ever been, without increase. *Cruquius* proves this in his Tables of meteors, where he proves there ever was an equilibrium of heat. Whole woods on fire have not encreased it. Don't you wonder, that neither plants or animals have suffered, as they would, in near 6000 years, if the fire had encreased ? But nothing has yet happen'd ; they would have perished with either too much or too little heat. The eggs of animals are burnt with a heat equal to 100, nay, in 70 they scarce are ever hatch'd. Insects eggs keep all winter, but die with any sharp heat. Hence the same heat is now as ever was from the creation ; neither volcano's, nor meteors, nor stoves, nor furnaces, nor bombs, have encreased it, and I hope to prove that these *pabula* have not changed it. All things have combustible matter, wherefore we will examine them all.

All vegetables will consume with fire, whether wet or dry ; all crude vegetables have water spi-
rits

rits that are odoriferous, and invisible, an *acid* that appears in a liquid form, an *alkalini volatile salt*, a *volatile oil*, a *fix'd oil*, a *black coal*, *white ashes*, a *fix'd salt* in these ashes, and *earth*: Now let us see what it is in these that is inflammable.

The plant first fumes and exhales in a *pellucid smoak*, the water with an acid or alkali in it; next a *black smoak*, and stinking exhales; then succeeds a *flame* which is clear of smoak, unless it goes out; if this smoak be received on any body, it makes foot; last of all the ashes are left, which in volatile plants is mere insipid earth, as in garlic, &c. (*sc. fetids and acrids*) but in other plants 'tis a fixed salt.

In dried plants all is the same, only the water is not so plentiful; in rotten plants, and dry, they scarce flame, they only shine and give out a little salt.

Hence then water has a great share in the flames; for altho' it can never be heated above 212° , and so can never be made to shine, yet if thrown on coals, it makes them burn, unless there be too much, so as to extinguish the fire; if thrown into boiling oil, finding 600° of heat, whether hot or cold, it forces the oil to bubble and boil over, and fly about; for meeting with three times more heat, and making its way to the bottom by its greater weight, it must be toss'd wonderfully; so if to a mortar a little moist, you pour in hot fix'd salt, it is thrown and toss'd about wonderfully, and with hazard to the by-stander; but this appears most in melted Copper, into which if one drop of rain or moisture falls, it flies out, throws down the furnaces, and kills all around.

Next, let us consider the spirits in vegetables; we find nothing in them fit to nourish fire; for if you throw them on the fire, they put it out.

For rosemary distill'd affords nothing inflammable, order it how you please, but it extinguishes it.

Then as for acids got from Box, Guaiacum, &c. made pure by rectification, and appearing in a liquid form, separated from all oil, they extinguish the flames; and the same happens from acid spirits got from balsams; nay, the acid got from Turpentine does the same. Sulphur indeed flames, but the acid flies off, and 'tis the oil only that feeds the fire.

As for volatile salts cleared of their water, spirits and acid, they fly off and don't flame, neither do the volatile salts produced from putrefaction nourish the fire: I understand the volatile salts cleared of their oils; for such will flame.

But oil when 'tis elemental, essential and pure oil, will flame, tho' less when rectified and render'd thinner by frequent distillations; that is, it flames more, but smoaks less; its fœces after distillations don't flame. When thus rectified it flames all away, and leaves no dregs. Drop a live coal into cold or hot ethereal oil of Turpentine, it is extinguished as if you dropt it into water. Pour this oil on the flame of a candle, and it puts it out; and the same happens to all essential oils whatever.

All cinders, if you exclude the air, or throw on water, or smother them with ashes, lose their fire, and are black; they soon take fire again, but don't smook; however their invisible steams will kill animals if a chamber be close shut; when their fuel is gone, they turn to white ashes, and will not afford fire; so paper whilst black when lighted, spangles till it becomes white ashes, and then no more. This black is oil, the spirits, &c. are gone; hence oil is only inflammable,

(z) The ashes are mostly mere earth with a little salt; fix'd or volatile; the fix'd salt won't flame. The ashes are so much earth, that workers in metals make cupels of them with water; they won't flame.

Again we now see what it is that nourishes elemental fire; till flame appears there is a thick smoak, when it breaks out, then this smoak vanishes (*a*); smoak then is a quick motion of mix'd parts, not yet set on fire fully: Flame then is smoak set on fire (*b*); a bright flame consumes all the matter without smoak, as may be seen in *Dalesme's* chimney, where all turns to flame and ashes.

The instrument invented by *Dalesme*, and much about the same time by *Fastel*, is as follows, *Pl. 4. Fig. 1.* *A, B, C, D*, is a hollow Cylinder of Iron plates, in whose base *B D*, is a grate *B D*; this Cylinder is exactly fitted to a cylindrical tube *E, F, G*, and the tube *E, F, G*, is of the same size with *A, B, C, D*, and of Iron, and is open at *G*, shut at *E*, if then the tube *E, F, G*, be first well heated, and charcoal put on *B D*, and on them some combustible matter, then the flame rais'd descends into *E F*, and goes by *F G*, and out at *G* (the chimney); now all the smoak going this way, is forced thro' the flame that fills the tube, whereby it loses its thickness and falls into flame, and makes no smoak, nor leaves any foot; I also caus'd the same machine to be made in another shape, *Pl. 4. Fig. 2.* *A, B, C, D, E, F*, is a hollow vessel of Iron plates,

(z) He relates here the method of making fix'd salts, which is done again at large in Vol. II. p. 51. Process 9, to Process 15. p. 68. wherefore I omitted it, not being much in humour with tautologies.

(a) This he has told us often before.

(b) So says Sir *Isaac Newton*.

sodered together ; 'tis only open at top *A, B, C, D*, at the height of *E I*, there is a grate *I, K, L, M*, then on the side *D F*, let there be an (*c*) elliptical hole *NO*, of the breadth of *M K*, and of the height of *E I*, to which is applied the tube *O, G, H*, open at *O N* and *H*, and of the same width ; put live coals on *L K*, the grate, to heat the vessel, at the same time the air in the opening of the tube *N, O, G, P*, is heated ; I put live coals on the part of the tube *NP* for the same end ; as soon as the air within the grate, and in the tube *N, O, G, P*, is heated, the heat that was first in the vessel *CK*, above the grate with the coals, begins to lessen ; then in proportion the heat in *F* under the grate, and in the tube *N, O, G, P*, increases ; so that the force of the fire with its flames is driven downwards, and then a coldness begins above the grate : Put in any combustible matter of whatever sort then on the grate, the smoak goes down thro' *O, G, H*, and comes out at *K* without smoak, and there will be a great heat and crackling whilst *CK* is cold ; moreover bodies that us'd to smell whilst burning, don't smell at all, but are all consum'd to ashes under the grate ; all the rest are driven into the space *L, F, O, G, H* : So that all the combustible parts are turn'd into flame, and smoak is combustible matter highly agitated, but flame is this matter shining by reason of the matter's being thoroughly heated. Again, Guaiacum distill'd, if you put a candle to the smoak coming thro' any chink, it flames ; smoak is then near a-kin to flame : Nothing gives nourishment to smoak but oil.

(*c*) It chances to be a square hole.

Soot is a woolly substance, it arises from smoak which gradually blackens the matter, and by degrees accumulates; 'tis very inflammable; it affords by distillation water and spirit, which extinguish fire, then oils that flame much, salt, and a black cinder.

Oil then is the only *Pabulum* of fire, and this of any kind (*d*).

Nothing crude from vegetables will nourish fire; wine produced from fermentation, and made pure, cast on the fire extinguishes it; and distill it into spirit, still its steam scarce flames; but re-distill it, it will flame away, which no part remaining in the dregs after fermentation will. Moist Vegetables heaped up do at last putrify and turn into flame, which dry ones don't, unless they be moistened. As soon as they grow hot and then cool again, the substance is rotten, but this rotten stuff distill'd gives out water that choaks the fire; and for the rest, it affords all that other vegetables do that are burnt or fermented.

Vegetables perfectly putrified being distilled, afford a fattish stinking water, which is a water and a volatile oily salt, both these extinguish the fire; next this water comes oil, volatile salts and thicker oil, the oil only is inflammable; especially the pitchy one. Lastly comes the *Phosphorus*, there remains the cinder, which is earth without fix'd salt.

As for water, spirits, salts and earth, they grow hot, and communicate their fire to other bodies, but nothing, even in gums, flames; but inflammable spirits and pure oils do always flame, so long as they last, and are the only matter that

(*d*) There is but one oil; all its differences arise from other mixtures, that are not oil.

nourish fire ; when these are taken off the rest won't flame ; the other parts are highly agitated, and help to drive the flame to the inflammable parts, and hinder their too sudden consumption.

Hence it is, that by this great agitation of the parts, the oily burns fiercer and stronger for the others being intermix'd ; for pure alcohol and other oily bodies, tho' they burn faster, don't burn so fierce.

All alcohols will mix with each other, and all essential oils will mix with each other ; camphire will mix with alcohol ; all these have a cohesive property , alcohol when in water looks like little eels, so do oils with alcohol ; the more perfect is the alcohol or oil, the less fiercely they burn, and the purer, the weaker is the flame. Let us now see how the fire and its *Pabulum* works.

E X P E R I M E N T I.

Immerse a brimstone match lighted, or a red hot cinder into spirit of wine, they are extinguished quickly ; let them touch the surface, it flames.

Cor. 1. Plunging then extinguishes, but touching the surfaces lights up a flame ; strange (e) !

Cor. 2. Fire then does not always make inflammable bodies flame.

E X P E R I M E N T II.

If alcohol be warm, and you approach within the steam with a lighted match, it presently takes fire, but only the surface is in flames ; if you boil

(e) Our author says this is a *Phænomenon* observ'd as yet by none ; 'tis very commonly seen every day.

it, and shut it up in a close chamber, and then approach with a candle, there is a flame seen all over the chamber, that lasts a moment ; the spirit burns only on the surface, not under it ; so that heating the spirit of wine, and making a large surface, are two methods of consuming a larger quantity of it ; but putting a red hot cinder into it, it is soon extinguished, as if it were put into water ; for the spirit of wine's heat is less than that of the hot cinder's, and therefore is it extinguished, it being reduced to 180° ; and nothing of combustible matter will flame with that degree ; besides plunging the coal, it is removed soon from the commerce with the air.

EXPERIMENT III.

I have often thought with my self, whether I could learn by experiments the action of fire upon its *Pabulum* ; I took spirit of wine and made it flame, and plac'd it under a glass bell, whose figure you see, *Pl. 4. Fig. 3, 4.* ; so long as the glass is cold, the spirit's flame makes it appear clouded, but as soon as it is heated it grows clear ; there can no smoke be seen, the flame is equal from the bottom to the top, but *striæ* run down the glass ; but these *striæ* are not spirit of wine, they are plainly wat'ry ; the vapour at top does not flame at a candle, but it extinguishes a match ; whether we can't separate all the water from alcohol any other way, or the alcohol turns into water, or the air supplies this water, I don't know. The alcohol is pure, made with salt of tartar, but water joins in easily with spirits ; this young *Jeoffroy* found as well as my self. In order to a further search into the nature of fire, I put matter into a cylindrical vessel that was all combustible, it flamed all away without smoke or dregs

dregs, turn'd into vapour, and that into water, I could go no further : I wish I could have had leisure to have discovered the quantity of water ; *Jeoffroy* says, half alcohol was water. This seems to happen to alcohol, as it does to spirit of sulphur ; in clear weather they get little spirit but strong, but in rainy weather they get more and weaker ; the air then supplies this water, and the spirit flies up and away. It may be that alcohol is a pure *spiritus rector*, that resides in a great deal of water ; for my own part, I was astonished to find, I could see nothing but water and a volatile vapour. All science is limited ; the *Pabulum* of fire turns into water, and becomes itself aerial.

E X P E R I M E N T IV.

Pour alcohol into any vessel, place it upon a charcoal fire, and put the glass bell over it, make it boil but not flame, yet it throws off no steam, meanwhile you see *striae* running down to the bottom of the bell ; when it has boiled well, apply a sulphur match to the upper orifice of the bell, it does not flame ; nay, this invisible steam extinguishes it ; but if you apply it under it, the spirit flames in an instant, and throws all about it furiously ; so that you must stand at a distance for fear of harm.

We find that the alcohol will flame with flame only, for boiling won't fire it.

The match takes hold of the steams floating in the bell in an instant, and all flames up till it reaches the vessel in which is the alcohol, and then these flames cease, and the spirit only flames till all is wasted. Hence spirit of wine whilst it boils and steams without flaming, disperses itself all around, and is unchang'd, because it flames so quickly ; but out of the glass it loses that force ; Why ?
Does

Does so much of the *Pabulum* of fire perish, as it exhales flame? Does it perish and can't revive? Is then the *pabulum* of fire reviv'd daily? that is, is oil and spirit re-created? by fermentation, putrifaction, vegetation and distilling? Or don't combustible matter consist of much water and elemental fire, which being let loose flies off?

EXPERIMENT V.

Oil of turpentine cold extinguishes a lighted sulphur match plunged into it, like alcohol; and so it does a live coal thrown in; hence oils do as alcohol does.

EXPERIMENT VI.

Put a lighted sulphur match to boiling oil of turpentine, it flames, but slower than alcohol; the finer it is, the less *fæces* it leaves behind, but never becomes alcohol, because it does not mix with water.

EXPERIMENT VII.

Place oil of turpentine in a vessel, boil it, place it under the glass bell, it burns as in the 6th *Experiment*, but it has a thick smoak which runs down the bell like water; 'tis very likely if these oils could be made as fine as alcohol, they would not smoak so as to blacken paper.

EXPERIMENT VIII.

Mix water and alcohol in equal parts, fire them, the spirit exhales more faintly than when alone, and leaves the water at bottom, and the flame goes out.

EX-

E X P E R I M E N T IX.

Dissolve camphire in alcohol, and set fire to them, the spirit burns away first, and then the camphire, and this appears in all cases alike; *sc.* That the finer oils burn first, the thicker last, and more fiercely as they are thicker.

E X P E R I M E N T X.

Set fire in the same manner to alcohol and oil of turpentine, the oil leaves a blackness on paper; the alcohol burns quietly but the oil crackles when it is fired, and blackens.

E X P E R I M E N T XI.

Set fire to the *Offa Lulliana* or *Helmontiana*, the alcohol flies off, and leaves volatile spirit behind; now camphire being suppos'd such a mixture, flames all away; hence 'tis a fine resin.

E X P E R I M E N T XII.

Mix alcohol and chalk, the alcohol flames away, and leaves the chalk unchang'd.

E X P E R I M E N T XIII.

Mix alcohol, camphire, oil of turpentine, and *Helmont's* offa, with chalk, add saw-dust, and make them all into a mass; set fire to them; the alcohol flames off first, then the oil, next the camphire, the rest remain at bottom untouch'd. The first steam is invisible, the next black and sooty. We see the order nature observes in flaming; 'tis easy to say that alcohol, oils, sulphurs, and, as
some

some say, nitres are combustibles, but to tell us what it is in them that is inflammable, we must say is hard.

S C H O L I U M I.

There is found then a body which is miscible with oils and water, clear, light, moveable and immutable, which when set fire to, flames all away, and this is the only and true *Pabulum* of fire yet known; whilst it lasted unconsumed, fire lasted; and when it ceas'd to flame, there was no further appearance of fire, therefore it may be deem'd a true *Pabulum*: all the time it flames you observe no smoak, which all others had; we indeed observe water to issue from it; it is all combustible and volatile, nor does it leave any spark, as naphtha, petroleum, camphire, and all others do; it does not smell as other combustibles do; hence 'tis homogeneous; it flames alone; hence the *Pabulum* of fire needs no consistent body; it unites with water, but repels it when in flames; it is produced uniformly from all vegetables by fermentation, without which 'tis not bred; the fire only shews it to contain water, but *Helmont's* boasts are vain, who says, by salt of tartar he can convert alcohol into half water; solid vegetables are changed as this alcohol is, *sc.* they consume as it does, and being collected do flame again, and leave ashes behind.

S C H O L I U M II.

Alcohol resembles fire, it coagulates blood, serum, choler, and whites of eggs; flesh, nerves, the bowels, and bread it hardens, as if the bread were toasted; Is it a magnet of fire? Does it effervesce with fire? All other oils tho' ever so
fine

fine and subtle, leave fœces behind them, when consumed with flames ; alcohol leaving no fœces, all washing away, and having no mixture but water, if that could be separated, what would it do? Would it act like thunder, or burn successively? As 'tis either earth, oil, or water that adheres to alcohol, could we separate these from it, and make it pure, it would be all fire ; the more mixture of water, earth and salts, the more smoak there will be ; mix a hundred parts of water to one of alcohol, or set fire to green tho' oily wood, or set marle or any fat earth to burn, we find no flame, 'tis extinguished ; yet if the inflammable be in due proportion, the stronger will the fire be for these mixtures ; the more ponderous are the combustibles, the stronger will be the fire ; wood before leaves, the cedar before the willow, the iron-wood before the poplar ; all bodies require heating before they will flame, and so much heat is required as to make the oily parts boil first ; but as this is harder to effect in more solid than lighter bodies, hence lighter bodies are made use of first to set fire to any stuff ; this fire is successive, not instantaneous, so that the lightest fires first, the most terrestrial last ; and therefore as that contains little oil, the fire is not then violent ; the fire is most violent, when 'tis in the middle way, between setting fire to it and its total consumption ; hence very combustible matter does not afford a strong fire : the force then of the fire depends equally, if not more, on the incombustibles, than the combustibles, from the rotation of the parts that are not combustible from reverberation, as Tin before fire roasts meat sooner. This rotation may be compared to a ball in a gun, which the powder don't conquer and set fire to, but it tosses it away violently. There seem to be two causes of fire, the elemental fire, and its

pabulum

pabulum alcohol ; hence mixtures make it more violent. The cause that unites the fire with its *pabulum*, is the pressure of the atmosphere, without this all fire would be choak'd ; which is proved thus, The air exerts a pressure on all Bodies, which, as may be seen by the Barometer, encreases and lessens ; whilst it encreases, the fire burns the stronger ; for 'tis as a pair of bellows, which being double, and blowing the fire on all sides, makes metals melt soon : so the air by its repelling force keeps the combustibles at work ; I dare not affirm that combustibles turn into *elemental fire* by burning.

*Of the PABULUM of FIRE from
ANIMALS.*

Animals having the same principles with vegetables, the *pabulum* is the same ; nay, phosphorus is made of vegetables as well as animals, as in mustard has been experienced. Steams from men and beasts may be set on flame, whether from the anus or pores.

*Of the PABULUM of FIRE from
FOSSILS.*

We observe the same laws to obtain here as in the other two preceding, that nothing turns into fire but oils ; and the thicker they are, the stronger is the fire ; no oil I have seen, mixes with water.

Naphtha is not so inflammable as we have been told.---Petroleum grows more inflammable by distillation, but not so fine as alcohol ; the purer oils are, the less they smoak ; coals smoak, and leave foot and ashes. Sulphur gives oil and earth ; these make it burn the fiercer : so that its

TOM. I.

G

effects

82 *The Elements of* CHYMISTRY.

effects are produced by elemental fire, oil, and acid.

Cor. 1. Elemental fire rarefies all Bodies.

Cor. 2. 'Tis uniform in all Bodies, and is not common to any Body known to us.

Cor. 3. It is omnipresent; that is, it is in all Bodies whatever, whether full or *in vacuo*.

Cor. 4. It is equally dispersed in all Bodies, unless some cause collects it or disperses it.

Cor. 5. That collecting cause is attrition.

Cor. 6. It expands itself around.

Cor. 7. But that expansion may be directed into parallelism, or otherwise.

Cor. 8. The Sun is this directing cause principally.

Cor. 9. Reflexion or refraction collects that cause.

Cor. 10. Hence is there a third manner of collecting it.

Cor. 11. Percussion is a fourth manner of collecting it, by Steel and Flint.

Cor. 12. This last fire is not from the Sun, as to its matter.

Cor. 13. It remains in Bodies for some time.

Cor. 14. The time it remains is proportionable to the densities of Bodies.

Cor. 15. Nothing can always retain it (c).

Cor. 16. What we have said hitherto agrees to elemental fire.

Cor. 17. The fifth manner of collecting fire is by fires; this consumes things into invisibles, and is supposed to be fire.

Cor. 18. Nothing but alcohol turns all into fire, whose *pabulum* entirely consumes.

Cor. 19. Oils also are next to alcohol.

(c) What does the Sun?

Cor. 20.

Cor. 20. Fire is not made anew, nor destroyed, it is the same it ever was; it is not heavy. *Boyle* wrote on its ponderability: *Homborg* has given us experiments on it. Quicksilver grows heavier by calcination with the flame of a lamp. *Du Clos* shewed, that antimony calcin'd by a burning-glass, grew heavier $\frac{1}{6}$, altho' it smoak'd. *Æiv. Reg. Antim. martial.* finely powder'd by the duke of *Orange's* great Glass, grew *3iij.* heavier, but lost it in a true fire: All Calces afford the same Phenomena; I doubt not these experiments, but 8 lb. of Iron got no weight, as I tryed it. All Bodies don't acquire that weight; *Du-Hamel* and *Boile-Duc* have found the affair otherwise. *v. Acad. des Sciences, p. 14, 15.*

Cor. 21. We see how fire may be encreased in any one part; we know how it dissipates or vitrifies, but we cannot say how far it can be augmented.

Cor. 22. The utmost effects of fire hitherto known to us, is a production of phosphorus in vegetables and animals, of glass in vegetables, and in fossils in melting of gold. It may be nourished when collected any where, by alcohol as its pabulum, or oils, and encreased by bellows, by the true action of the Atmosphere, &c.

Cor. 23. Having considered how it may be collected and nourished, I shall pass on to shew how it may be produced by mixtures.

Of HEAT arising from the MIXTURE of
VEGETABLES.

Verulam, Boyle and *Hook* have considered this point, to wit, that heat has arose by mixing things together, and which grew hot or cold immediately, and presently returned to their pristine state.

I will first shew you the instruments used in this affair. *A, B, C*, is a great Thermometer filled with spirit of wine ting'd, so long as it may be free in *M, B, A*, to place any bodies in, the degrees are marked on the board *E G*, then place all *AB*, into any vessel, pour on the liquors one after another, and stir them. *Pl. 5. Fig. 1.*

E X P E R I M E N T I.

Try these liquors, the Thermometer stands at 44° , plunge it in water it is at 44° ; plunge it in spirit of wine, it is still at 44° ; pour the water to the spirit, and stir the glass, it is at 55° , then it has rose 11° (*d*); hence the water and spirit were equally hot before the mixture. 2. The air, spirit and water were equally hot before their Commixture. The air and water, the spirit and the air were equally hot. 4. The spirit and water grow hot presently, not from the heat they had before. 5. They grow hot from some physical cause upon mixture. 6. They only grow hot immediately upon mixture, not tho' you move them afterwards. 7. Then application of parts is the only reason of their heat. 8. This heat is elemental fire, as appears by the Thermoscope. 9. Much heat is lost while the Thermometer heats.

E X P E R I M E N T II.

The Thermometer being at 44° , water and alcohol at the same degree; mix, and the Glass rises to 62° ; hence, 1. All may be gathered, as in a forenamed experiment. 2. Alcohol heats more

(*d*) Motion makes the liquors warmer, and that makes them mount in the glass.

with

with water than spirit. 3. This heat depends on the quantity of alcohol. 4. Alcohol and alcohol mix'd don't produce more heat, but with water it does. 5. The purer the water is, the more is the heat.

EXPERIMENT III.

Alcohol alcalis'd, water and the glass are at 40° , mix, and it stands at 54° ; hence, 1. The same may be said as in Experiment 1st and 2d. 2. Alcohol alcalis'd grows hotter than spirit of wine, but less than water and alcohol. 3. The sole heat is from alcohol and water.

These things may be compared with what Geofroy mentions, in his *Monum. Act. Reg. Sc. Anno 1723, p. 13*. This is observable, that heat is produced only in the moment of commixture, which is greater the quicker you do it, and not afterwards, altho' you should shake them together; for the heat abates every moment. Wherefore we infer, 1st, That the physical cause of heat arises in the moment of contact; the liquors grow *opaque* whilst hot and pellucid, afterwards bubbles arise in the moment of mixture, but presently disappear, the reason of which is dubious. 2dly, This heat does not arise from the united substances, but from the union of the parts; and gun-powder does not sooner flash then this heat arises. 3dly, We can't determine the reason, but suppose it to be attraction that causes the heat, and repulsion the cold; once this attraction is ended, there is a rest, from whence the cold proceeds. 4thly, There is a determinate time therefore for raising this heat, and producing this cold. 5thly, Hence cold parts bath'd with alcohol, grow warm.

E X P E R I M E N T IV.

If Wine and Water be mix'd together, little or no heat is produced, whence being equally warm of their own nature, they remain so. *2dly*, Therefore wine being applied heats no more than water. *3dly*, Therefore the heat produced in us after drinking of wine depends upon the stimulus, not upon the heat that pre-existed in the wine.

E X P E R I M E N T V.

Vinegar and water mixed, produce no heat; wherefore, *first*, Their heat being equal before, were equal afterwards. *2dly*, The cooling heat of vinegar depends upon some other physical cause.

E X P E R I M E N T VI.

Oil of tartar and water, before and after the mixture are equally warm; whence the most fiery liquor does not appear warmer than water, which is a paradox. *2dly*, A fiery liquor mixed with water, does not diminish its coldness. *3dly*, A fiery alkaly diluted with water excites no heat with any other water. *4thly*, Therefore the same mixed with the blood will raise no heat as to this respect.

E X P E R I M E N T VII.

Water and oil of turpentine mixed raise no heat; Whence, *1st*, A heating essential oil has no more heat in it than common water. *2dly*, This oil being near as hot as alcohol, does not heat

heat like it. 3dly, Therefore can't this oil heat the water of our blood.

EXPERIMENT VIII.

Mix a perfect alcohol and oil of turpentine, they produce no heat ; wherefore alcohol mix'd with the oils of our blood, will produce no heat, tho' it may in the serum of it.

EXPERIMENT IX.

Spirit of vinegar and oil of turpentine apart, mount the glass to 44 degrees, but mix'd, gradually they raise it to 45 ; wherefore vinegar and the oil are equally warm. 2dly, By mixing them some heat arises. 3dly, We see that acids with oils produce heat, and the heat here is little, because the strongest vinegar contains but an 80th part of acid. *Homberg, Act. R. Sc. F. 1. p. 52.* 4thly, Therefore vinegar, with respect to our oils, creates some heat ; and in this manner vinegar differs from water.

EXPERIMENT X.

Vinegar and alcohol being equally hot with the air, namely of 42°, being mix'd, raise the glass to 52 ; hence alcohol and vinegar of themselves are equally hot. 2dly, After mixture heat is raised. 3dly, Alcohol raises more heat with vinegar than oil.

EXPERIMENT XI.

Oil of tartar and of turpentine mounted the glass apart to 45° each, but mix'd to 48°. Hence,

1st, They are equally warm of themselves. 2^{dly},
A notable heat is rais'd in the mixture.

E X P E R I M E N T XII.

Vinegar and oil of tartar, each apart, mount the glass 46°, and being suddenly mix'd, they became no warmer; but here I mix'd three of vinegar to one of oil of tartar; hence in the uniting of these opposite salts fire is not collected.

E X P E R I M E N T XIII.

Alcohol and oil of tartar, *per deliq.* of equal coldness with the air, raise the glass from 64 to 68.

E X P E R I M E N T XIV.

Alcohol of equal warmth with the air, to wit, of 47° blended with dry salt of tartar made it ascend to 51°.

E X P E R I M E N T XV.

Put one part of dry Salt of tartar to three parts of water, they mount the glass from 47 to 57.

E X P E R I M E N T XVI.

Mix three parts of either with one of dry salt of tartar, they mount the glass from 43 to 49.

E X P E R I M E N T XVII.

Mix one part of dry salt of tartar with three of oil of turpentine, the glass rises from 43 to 48.

From

From all these we learn, 1st, That all simples treated chymically are equally hot with the air they reside in. 2^{dly}, They only grow hot upon the mixture, and return to their former temper. 3^{dly}, This heat therefore is not produced from their Substance, but their union. 4^{thly}, Alcohol and water are the chief that have this power of generating heat. 5^{thly}, Salt of tartar and water are the chief amongst solids and liquids mix'd, that generate this heat. 6^{thly}. Next to these, alcohol and salt of tartar have the chief power. Now let us view animals.

Of HEAT producible by the Mixture of Animal and Vegetable BODIES.

EXPERIMENT I, tryed various ways.

Urine kept till it is of equal temper with the ambient air, mix'd with equal quantity of water of the same heat, does not change the glass; if mix'd with alcohol, it rises from 38 to 49; 'tis not changed with oil of turpentine: with salt of tartar it rises from 38 to 39; with the strongest vinegar it is not changed, nor with spirit of urine; with salt of urine it falls two degrees; with spirit of nitre it rises from 38 to 93; with spirit of salt it rises from 39 to 43, with oil of vitriol from 39 to 54.

EXPERIMENT II.

Putrified urine of equal temper with the air, mixed with water, made the glass descend a little; with alcohol it mounted from 38 to 45; with oil of turpentine no change; with oil of tartar from 38 to 36; with the strongest vinegar from 37 to 38; with spirit of urine from 38 to 36; with

with salt from 38 to 32 ; with spirit of nitre from 38 to 40 ; with spirit of sea-salt from 38 to 41 ; with oil of vitriol from 38 to 45.

E X P E R I M E N T III.

Salt of urine sublim'd with sand, from fresh urine mix'd with water, made the glass descend from 40 to 38 ; with alcohol it rose from 40 to 41 ; with salt of tartar from 40 to 45 ; with the strongest vinegar thicken'd to half, from 42 to 44 ; and with spirit of nitre from 43 to 60.

E X P E R I M E N T IV.

Spirit of salt-armoniac made salt of tartar, mix'd with an equal quantity of the strongest spirit of vinegar, being both of equal warmth with the air, the glass from 44 to 48, with the strongest vinegar thicken'd to half from 44 to $47\frac{1}{2}$, with spirit of salt distilled with bole, and rectified from 46 to 64 ; with spirit of nitre distilled with bole from 46 to 82.

*Of producing H E A T by the Mixture of
F O S S I L S.*

E X P E R I M E N T I.

To three ounces of water hot to 47° , put one ounce of powder'd nitre, the glass descends to 36° ; to three ounces of water hot to 48° , put one ounce of borax powdered, it descends to $45^{\circ}\frac{1}{2}$; with three ounces of water hot to 46° , put one ounce of sea-salt, it descends to 43 ; to three ounces of water hot to 47° , put one of salt-armoniac, it descends to 28 ; to three ounces of water hot to 45° , put one of oil of vitriol not recti-

rectified, it rises to 60° ; to two ounces of pure alcohol hot to 47° , put one of oil of vitriol not rectified, it ascends to 60° ; to three ounces of spirit of vinegar hot to 46° , put one ounce of oil of vitriol not rectified, it rises to 60° . Ceruss, whilst it effervesces in weak *Aq. fort.* makes it rise from 44 to 57; filings of tin, whilst it effervesces in *Aq. Reg.* it rises from 44° to 56; filings of iron, whilst it boils with *Aq. Reg.* makes it rise from 44 to 160° .

I have tryed several other experiments, but fear I shall be too tedious; one thing I have to say, If you take observations on the three kingdoms, and mark them down, this history will at last be complete with respect to heat raised on mixtures of Bodies on each other; for my own part, I have not been so accurate as I should have been, lest I should abuse your patience. I have used the largest Thermometers in these trials; and considering the small quantity of liquors so large a body is immers'd in, it may somewhat change the events; but if you have a mind to try them alone, I advise to *Farenheit's* Glasses made with Quicksilver, they being the most accurate of any.

Of FIRE produced in a cold BODY, barely from the Access of the AIR.

As Chymistry is always inventing new things, so nothing after Gun-powder, is more wonderful than *phosphorus*, which upon the contact of the air, rises into fire.

Animal humours, upon putrefaction, and calling off the volatile oils and salts, leave a coal; which mix'd with three parts of sand, or fine powder of wood, or two parts of charcoal, and a half

half of alum, and put into an earthen retort, and called off by a fire of the last degree, gives the phosphorus in water, which the recipient contains; and this is form'd under the water upon the fire into rolls. This phosphorus of *Crafft's*, *Kunckel's*, or *Boyle's*, is kept in water, but as soon as it touches the air, it is set on a flame at once, and can hardly be extinguished; whilst it remains in the water, if the air be warmer, it shines in the dark; and being viewed by a Microscope, in the open air, and warmer than usual, it seems to boil, and then bursts out into flames, and leaves behind it an acid like *Oil of Vitriol*. It being analys'd, resembles Sulphur in nature, but wax in substance; but it differs from either by its easy ascension. *V. Boyle Noctiluc. Aer. Slare. Act. Phil. 1683, p. 1457. Homberg Mem. Math. & Phys. An. 1692 p. 74 ad 80. Nieuwent, p. 520. Hoffm. Diss. Chym. Phys. p. 336.*

There is another phosphorus invented, which I had from *Homberg 1712*, published 1716, p. 60. in *Diar. Eruditor.* the first was found by one seeking the Philosophers Stone in urine, and the latter by another searching after the same in human excrements; 'tis made thus, Take human dung, or flesh, or any soft part, or any vegetable flower, fry it to a black powder in a frying-pan; of this powder take one part, and alum three or four parts, mix them, burn them, always stirring, till they smoak no more; always powdering them afresh, if the alum coagulates; put this black, dry powder in a dry Glass-bottle of a small bore; cover the orifice with a loose paper, that the air may pass and repass, put this bottle into a crucible, whose bottom is covered with sand, so as it touch not the crucible; put this crucible on coals with the bottle in it, encrease the fire, so as the crucible, sand and bottle may be heated; keep
all

all these on a violent fire for an hour ; whilst it is thus hot, wax up the bottle that no air get in, let them cool gradually, and you have a black phosphorus ; pour out some of this black powder into the air, it fires in an instant, but loses its force presently in air, but keeps for three months if no air gets at it. If any moisture gets to it in the time of preparing of it, the experiment is lost ; and the air is expell'd by the fire whilst it is making ; in the calcination, all water, air, and the volatile acid are left, and nothing remains save the strong acid and dry earth ; such Bodies grow hot at the approach of the air, which enters the *meatus*, agitates and raises fire, or perhaps some other cause may concur ; but be that as it may, who will undertake to determine the power of fire ? Who would have believed this 25 years ago ? Who knows what will be found out hereafter ? What if such a powder should fall into a barrel of Gun-powder ?

Of FIRE produced from cold FOSSILS
by WATER.

If the dust of Iron lately filed, and not rusty, be mix'd with pure Brimstone in equal parts, so as the powder be very subtile, keep this as long as you please dry, it remains untouch'd, but if you make a paste of it with water, after some time it heats, and at last flames ; after flaming you find a brownish blackish calx, which with water gives a *vitriolum martis* ; a great quantity would make a *volcano*. *V. Hist. Ac. Reg. Sc.* 1700, p. 52. *Monum.* p. 107. The acid fixes on the Iron, and heats the Sulphur into flames. *Hoffman* relates another experiment, *Diff. Phys.* Ch. 169, by mixing oil of vitriol ℥ij , water ℥xij , keep the bottle, holding them in a moderate

derate heat, then put in 3ij of filings of Iron gradually, a white steam arises, of a nidorous smell, which is lighted by a candle; thus we see by water how flames and fire are produced, and doubtless many more will be found out in after-ages. Moist hay also flames.

Of FIRE produced by the Mixture of cold LIQUORS.

Mix *Sp. nitri fumantis* 3j, and any essential oil (Cloves, Sassafras, Turpentine, Carways) either in equal or to 3j 15, you see how soon they flame up, and leave a Resin behind. *Borrich Act. Hoffn.* 167. *Hoffman Obs.* 38, 42, 123, 127. *Slare. Act. Phil.* N° 150. p. 291.

If now all that has been said be seriously weighed, we may perhaps pronounce on the nature of elemental fire. 1. It is *corporeal*, because it is extended and mensurable; if a Globe heated be plunged into water, it heats the water, and extends itself all around, and each part is heated as the distance from the Globe, as a Thermometer informs us.

2. It is *moveable and capable of rest*; this we experience, that it can disperse itself successively, and therefore can rest; hence can it be augmented and lessened.

3. It resists, so that another Body cannot possess the same space; that is, it is impenetrable, (*Ἀντιτυπία* (e) is the Greek word for repercussion;) it may be, and is evidently repercussed from Bodies into which it enters, as appears in *Villette's Speculum*, where it is reflected so as to burn all

(e) Ἀντὶ contra and τύπτω verbero, That is reverberation or eating back.

it touches, and the laxer were the speculum, the less would it reflect and heat; but it is reflected, or the Glass would be consumed. *Tschirnhauser's* Glass refracted upon a compass needle, moves it round; therefore this motion arises from a percussion. It is immutable in its figure, tho' it changes all other things; I cannot say whether it be *heavy*, but it is not determined to any centre; 'tis every where, subsists of itself; and all these we have seen proved by experiments.

4. It is in its constituent parts the *least of all Bodies*, because it penetrates all Bodies whatever; it fires a Globe of Gold red hot, and were this split, you would find heat, light, and all other properties of fire in every part of it: All Bodies have pores that admit it: Air, water, spirits, salts, oils may be excluded, fire alone cannot be hindered from entering and returning: Indeed gravity and magnetism pass thro' all Bodies, but their manner is not known, altho' they act instantaneously, but fire acts successively; hence is its nature manifested; its elements are the least of any Body yet known; I know no corpuscles more subtile than those of fire. The pores of Gold cannot be seen by a Microscope, tho' ever so finely drawn, even into $\frac{1}{1050000}$ of an inch; yet fire finds its pores and enters it. Suppose a great golden Globe on fire, yet it would find its passage out of it; and a small heat enters as well as a great one; to be hot and to be cold, is only to have a greater and less heat or fire. Its subtilty is evident then, and much more so, if light and colours be fire; for if there be a hole in a dark chamber, we can see all objects thro' this small hole, that is, each ray, so innumerable as they are, is seen; and upon a paper, you may thro' a convex glass see all very plainly, which shews the infinite subtilty.

5. The

5. The Elements of it are most *solid* of any Body ; for it enters thro' all Pores whatsoever, and continues itself immutable ; it divides all Bodies by forcibly entering them, and expanding itself all around ; it is the greatest mover and changer of Bodies, without being altered itself, therefore is it the most solid of all others.

6. It is the most *polished* of all others, if its Corpuscles were rough, hook'd, or woolly, it would stick somewhere, and not enter so freely, we therefore believe them to be small spheres finely polished, and the easy Reflexion and Refraction of them seem to argue them to be of this figure.

7. It is the *simplest* of all Bodies ; that it is every where alike ; suppose its nature to be a solid small sphere, every particle of it is the same in figure, bulk and solidity. Sir *Isaac Newton* seems to stand in opposition to this simplicity, having divided one pencil of a ray of light into seven others, each distinct from the other ; but then consider how subtile and simple is that one ray ! for notwithstanding the diversity of colours manifested in one ray, still it is the simplest of any we know.

8. It is *moveable*, so as never to be at rest almost ; let the Glass be settled down to 33, or even 40, yet still there is Motion ; and the Swift-ness of the rays of light can neither be exactly determined by *Romer* or *Hugens*, as *Cassini* and *Moraldus*, only the less successive is their motion, the quicker are they communicated : If water were to be reduced into glass by cold, yet still there would be motion. So many degrees of heat are required to make water fluid, and so many more to make Metals liquid ; so that 'tis greater and less Heat that makes all things liquid.

Fire is not bred nor encreased, it is only made to appear, whereas before it lay concealed in Bodies; so that fire does not multiply nor decrease, there being the same quantity of fire now, and no more than there ever was; when therefore any body is set on fire, the *pabulum* is set on fire by the Elemental Fire that lay hid: This *pabulum* is not fire, nothing can produce fire where there is none. This Elemental Fire is the chief and only mover of all things, it neither is bred, nourished nor reviv'd; it pre-existed where-ever it appears.

It matters not then what sort of fire Chymists make use of, whether elemental or artificial; fetid or sweet things set on fire afford the same fire; so that all fire is elemental, and if we can adjust the degree of fire to be made use of, it is all one whether we digest, distill, calcine, &c. with the Sun or common Fires, each of them produces the same effects, so the degree be equal, so the fire be pure; for if open fires in furnaces act otherwise than dioptrick and catoptrick Glasses do, this difference arises from particles mix'd along with the fire, and not from fire as fire. Thus the fire raised by alcohol is the purest, and sullies Bodies the least; next to alcohol the purest is essential oils rectified with fix'd Salts, so is Naphtha, Petroleum, and such like native oils; next these is Wood fire, Peat or Turff fire, much commended by Mr. Boyle; which burnt and extinguished, is the fittest for use again; next to these are Pit-coal fire, they consist of Naphtha or Petroleum, and Earth that vitrifies; lastly, Fire raised from the dung of Animals dried.

The diversity of effects are various, Bodies depend on the diversity of the *pabulum*, and I shall shew you this by experiments. Wood and Peat-Turff Fires give out a steam that hurt the eyes, and make us cough; but if you make a black

To M. I. H coal

coal of them and extinguish them, and set fire again to them in a close shut up Room, they kill Animals quickly (i). We shut up an animal in a Glass, and exhausted the air, so as it could live some time, then by a tunnel we let in the smoak, and yet it lived, till we let in the invisible smoak, when it came from the fuel quite on fire, for then the animal died quickly. *D'Acosta* tells us, that the miners in *Peru* can't melt their Silver from the Glebe by the strongest fire and bellows, but if fire be made by the fall of water, it does presently. We see how minute circumstances alter effects.

Let us view what remains on the history of fire; fire dissolves some, but not all things; a gentle and long continued fire changes quicksilver into a fix'd powder, which if it be encreased, makes it fly off; one degree fixes then, what another makes volatile. Antimony, Lead, and Coral calcin'd by Glasses, grow in bulk and weight, somewhat then is added to them; so Quicksilver well depurated and digested long in Glass phials, is fixed, its weight is encreased, and some part is chang'd into good metal; hence fire adds somewhat to Bodies. Gold, Silver, Osteocolla, Glass, Selenites, Talc, Virgin-sand, are not changed into other Bodies, nor Elements. *V. Helmont, Boyle.*

(i) A strange wonder! That an acid steam diluted with water should not kill, whilst a pure acid should! At first a wat'ry acid steam arises, and tho' this be prejudicial, yet the animal will survive it, but when nothing but a stronger and concentrated acid flies off, then no animal can bear it; consider Sulphur on Fire, what can survive its steams? Thus have I known the Captain of a Collier Ship lie as if dead for hours, by the steams of his Coals set on fire accidentally.

Fire does not separate all things, altho' we know them compounded, and they are separable by other methods ; Gold, Silver, and Copper melted together, are not to be separated by fire ; by Lead $\frac{1}{2}$ you gain the Copper ; the Silver is got by Spirit of Nitre, and the Gold is at bottom black ; the Silver is not easily got from the Spirit without loss ; you get by fire the Lapis Infernalis, which melts like metal ; but put in Copper, and the Silver drops ; sulphureous metallick Glebes melt together, or fly off together : How often, in vain, have Essayers tried to get Metal pure from Sulphur, yet this they do by fix'd Salts, which makes the Sulphurs fly off, and the Metal settles ; Antimony in the fire either flies off, or if the fire be gentle, remains ; but use Nitre, Tartar, or Iron, and give fire, the Sulphurs fly off, and the reguline part stays. Aqua regia melts the Regulus, and leaves the Sulphur ; Salt-armoniac in a small fire remains, and in a great one flies off, but add any fix'd Salt, you gain the volatile, and the Sal-marine stays. Sublimate in fire mounts up mix'd with Metal and Acid, but add Iron or fix'd Salts, you gain the running Metal. *N. B.* Attraction does what fire cannot.

Neither does the fire separate Bodies into their pure elements ; for water kept after distillation grows mothery, smells and grows thick ; Spirits abound in Water and Salts, Oils contain Salt and Earth, and Earth contains fix'd Salts.

Fire often unites Bodies, as appears in making Glafs with fix'd Salts, which you may separate again by mixing more fix'd Salt, and then pour on acid and the Sand returns. *Soaps*, *Aqua Regia*, and *Electra* of Metals, do evince the same thing ; hence fire in many instances compounds as well as separates ; that is one degree mixes and another depurates Bodies ; the case appears

in red *precipitate per se*, which a gentle fire makes, but the fire encreas'd makes it fly off.

The same degree of fire altering the circumstances changes the scene: *Hook* put a coal into an Iron-box close screwed, and put it on the fire, but taken out, it was not burnt; hence the Air is a *Menstruum* that helps the dissolution of Bodies; *Helmont* observ'd this, and *Papin* too; I burnt Guaiacum to a black coal, which could not be changed, till I put a Spark into it, and it then turn'd into white ashes, and the aromattick Oil flew off. Camphire flies off in flame in water, but put it into an alembick, and it mounts again into Camphire; Sulphur sublimed 100 times, is still the same, but if there is a chink in the Retort, it flames, and an Acid is got from it. Amber in open Air flames away, but in a Retort you get Water, Spirit, an acid Salt (*k*), and Oils.

Lastly, The degrees of fire vary things; for the white of an Egg by a heat of 92° in the air turns liquid, thin, sanious, fetid, putrid; 'tis a volatile Salt, and melts like water, and can never recoagulate by being boil'd in water; but in 200° it grows hard, keeps for ever, and affords water; in 400° , in a Retort, we get Phlegm, volatile Salt, Oil and Coal. But it would be tedious to say more on this subject.

We now come to instruct you how to manage fire for chymical Purposes; by *Farenheit's* Thermometers we can manage them to what degree we please: The Ancients divided their fires

(*k*) No, 'tis a neutral Salt; for by a fix'd Alkali you gain a Sal. Vol. Succini; and the Acid is at Bottom join'd to the fix'd Salt.

into four degrees, but we now can manage them to what nicety we please.

The first degree of heat is from 1° to 80° . This degree is fit for Vegetation, some require a greater, some a lesser degree to be green part of or the whole year, as Ever-greens; each requiring its natural Degree: If you would impregnate Oil olive with the flavour of a Rose, put a Rose into the Oil, and digest with a heat of 56° . If you would make a tincture of Saffron with Alcohol, the same degree does.

The second degree is from 40° to 94° , which heat is equal to the heat in human bodies. The Eggs of Insects were not destroyed by a severe winter, but, sticking to the plants, revived with the heat of the Spring; they live then with little heat: Fishes that have *Gills* live in water with 34° of heat, and they will bear water hot to 60° , and beyond: But Fishes that have Lungs live with a heat from 33° to 94° ; and this heat is required to make Elixirs, volatile Salts, Tinctures, and the Coction of Mercury for the Stone.

The third degree is from 94° to 212° ; water boils in this heat, it separates the Spirit from every Vegetable and Animal, and dries the rest; it renders the Oils volatile, it serves for distillations of Oils and Waters; it coagulates scum into a thick substance, and it kills all animals: As it has this effect upon animals, how can we bear such heat, and as such a heat is required to gain volatile Salts, how can there then be any volatile Salts in our blood (1)?

(1) This is very weak Reasoning; May we not say the same of Hartshorn? when certain arguments may be brought to convince us of its pre-existence.

The fourth degree is from 211° to 600° . In this degree all Oils, Lixivia, Quicksilver and oil of Vitriol boil and are distilled; it melts Lead and Tin, and mixes them; Soaps, Salts and Oils are rendered volatile by it; it converts solids into coal; it sublimes Sulphur and Salt-armoniac.

The fifth degree begins at 600° , and by it all things melt, fix'd Salts, Oils, Sand, Lime, either vitrify or fly off; Gold, Silver, Copper, Iron, and Glass continue the longest untouch'd.

The sixth degree is the dioptrick and catoptrick heat; this changes all things and even Gold; it vitrifies all things, as far as we see: If then the earth were to be consumed by fire, it would turn into Glass.

Now as the whole art of Chymistry consists in directing the fire, we shall proceed to instruct you in it.

It is harder to preserve cold for any time, than to augment heat; we must chuse a proper pabulum; Alcohol gives a moderate, equal flame, which by keeping in so many cottons in one lamp, as the Thermometer will direct you, to come at the required heat; next to Alcohol may be us'd Hay, Straw, dry Leaves, Hairs, Feathers, Saw-dust, Buck-wheat, Skin, Bran, Oils, Tallow, Wax, Camphire, Pitch, Rosin, Sulphur, dry Wood, Metals, Coals, laid on plentifully; for the more fuel, the stronger is the fire; the distance varies the heat, as the reciprocal *ratio* of its distance; but who knows whether fire contracted into a point, mayn't do more than if the whole fire acted, for it seems to acquire new forces not depending on the vicinity; for the fire often is found to decrease at a small, and heat at a greater distance.

Lastly, The agitation and compression of fire within a Furnace; for thus its violence is increased.

creased, as it is by bellows also, which workers on metals know well, when they have double bellows to blow on all sides the fire to its centre. These are the causes of the violence of fires.

Thus have I finished the natural history of fire ; if I have succeeded, you must judge : I believe, however, it will appear from hence, that a chymical fire of a determined matter, degree and application, acts always alike on the same object, as to separation or union ; but without these it is not possible to determine what changes will be made ; wherefore mind all I have said, and Chymistry may be rendered perfect. Observe the degree of fire, the succession of degrees, the pabulum, the weight of the air, its heat, motion, winds, and the object jointly, and you will succeed. I shall add somewhat more on the nature of fire, That fire wants not Air, Nitre, Pabulum, Sulphur or any other Body ; that Naphtha and Petroleum are fir'd at some distance from the flame, *Diar. Erud. p. 53. 1775.* that Bodies anointed with *Naphtha* and set fire to, burn under water, *ib. p. 104. 1683.* Naphtha is set fire to by a candle in a lanthorn, *Phil. Transf. 100. p. 188.* Gunpowder was fired in a machine under Sea water, and its noise heard above water, *Sinclair, p. 301.* *Sibbald* says of lake *Strath-errick*, that it never freezes till *February*, after that one Night freezes it ; and a certain river, *Ph. Transf. N^o 56. 1139.* never freezes ; and there is a cave a league from *Befanfon*, 300 paces deep, which in summer affords more ice in one day, than carts and mules can carry away in eight, but in winter it is a running river ; vapours from it betoken rain. In hot-houses, and near furnaces, it is colder near the fire, the fiercer it burns.

Thus have I search'd into the nature of fire, that excites such motions, and produces such

wonderful changes in Bodies. I submit what I have said to your re-searches, and hope your great sagacity will assist you to promote these enquiries, and communicate your trials to the publick; there is doubtless a great deal more to be discovered, which will instruct you to admire and adore the power and wisdom of God, the great Author of all.

Of the A I R.

The next in order is the air, which is yet more compounded than fire; we shall also proceed in the enquiry of its nature, as if we knew nothing concerning it; we understand by *Air*, that fluid that is not perceptible to us, but as it resists motion, that surrounds us, in which we live, and without which we can't breathe or exist.

It is the universal instrument nature uses for all its works; for in it all kinds of Bodies are plac'd, perform their motions and actions, which spring from their own nature, or are produced by their mutual or relative condition. It mixes with all Bodies, may be drawn from all things; hardly any thing operates without it, if we except gravity, magnetism, attraction and repulsion. Chymistry does nothing without its assistance; perhaps the Alchymists Stone may be made *in vacuo*, nothing hindring its maturation more than crude air.

It excites fire, preserves it, and directs it, and fire ceases without it; I speak of fire manifested by a pabulum, and by which nature and art do their operations.

Nothing lives, grows or acts without it; for if to live be to promote the Circulation of the juices, to convert them into their own nature,
and

and to encrease their Bulk, nothing of all this can be done without it.

It may be wondered I should even affirm that Fossils want its assistance; for as they want a subterraneous fire to perfect them, and as this fire can't burn without air, the deeper are these fires, the more ponderous will the air be there, and act the more forcibly; but more of this hereafter.

As to Animals and Plants, neither the eggs of Animals are hatch'd, nor the vilest Plants do grow where the air is not, is at rest, or is hermetically seal'd up; wherefore its active properties are to be known by Chymists, Physicians and natural Philosophers, because by it only they are let into the causes of several operations.

As it escapes the notice of our senses; as Microscopes are of no use to discover it, and as it is so compounded, as to contain all sorts of particles in it, even Gold, it is hard to find out its nature: Let us therefore take a view of its properties apart, and then consider them jointly, and we shall have a true idea of it.

First, It is a *Fluid*, and in all instances whatever it plainly appears that the air never loses this property; for in cold to 44° , colder than ever was known by nature, under the strongest compression and coagulations from mixtures, in all compositions where it resides in bodies, in all liquors where it lodges, in all fermentations where 'tis called factitious, in vessels, in ice, and the rest, it still shews itself in a fluid form, and exerts itself upon occasions; so that the two elements of fire and air are always fluid; indeed I once thought I saw the air sparkle, but it only appear'd upon second thoughts to be small particles of water that float in it to be frozen, and that reflected the Sun-beams to my eyes.

1st, The subtilty of its parts contributes to this fluidity ; so small are they, that a Microscope gives no notice of them ; and tho' they are less than those of fire, yet they can't enter denser Bodies as it does ; for put leather to the bottom of the air pump, suck, nothing enters, but oil, wine, &c. do presently enter. See Mr. Boyle.

2^{dly}, It is easily divided, for we can move Bodies any whither thro' it. This I call *Lubricity*.

3^{dly}, It attracts itself, tho' it is easy to separate one parcel from another, yet by the bubbles that arise, and at last unite together upon the commixture of liquors, there seems to be a *Nisus* towards a coalition, and a retention of its size and spherical form ; this may be an effect of compression or repulsion ; be it so, yet still there is a force that makes it tenacious of its figure.

If we examine this cohesive force, we find the airy particles mix like Salts with Water, and lurk in Bodies ; we observe that a large bubble flies off, and leaves the liquor less capable of bubbling after.

Its imperceptibility is evident from some experiments, which but for them we should not have understood ; for it resists Bodies, and that resistance is as the encrease of the velocities in a duplicate *ratio* of the Bodies mov'd. See *Marriotte*. And these experiments are understood of the whole air.

The air is heavy, and *Torricellius*, *Guerick*, *Pascal*, *Boyle*, and *Marriotte* have evidently proved by experiments the weight of the Atmosphere ; it is however difficult to measure the exact proportion between the gravity of the air and that of other Bodies together, because the air's weight varies every moment ; because Rains, Meteors, Storms, &c. vary its gravity ; and therefore do all effects depending

pending on this property. A series of observations continued for these 86 years have shewed us its utmost range of rise to be $30 \frac{1}{2}$ in the tube, and its fall to be $27 \frac{1}{2}$: Mr. *Nic. Cruque's* meteorological tables do shew us at one view, to a great accuracy, all the causes that concur to encrease the weight of the Atmosphere; its weight to water is nearly as 1 to 850.

The incumbent Atmosphere presses continually on all Bodies, and the quantity of this pressure is easily computed by the height of the Quicksilver in the weather-glass; for know the base and height of the mercury, and its weight being known, you know how much a column of the Atmosphere weighs. The nearer you approach the centre, the heavier still is the air; for fluids press upon their bases according to their heights; hence the higher Bodies are from the surface, the less are they press'd upon; and the more are Bodies pressed when the air is heaviest, and least, when lightest; hence this pressure varies; it is then resisted, and more if the Bodies be elastick; hence is there a perpetual Oscillation in the air, as its weight encreases or decreases: This vibration being encreased by fire also, there is a constant motion in all things, from fire and air; hence the air does not act on water, because nothing can compress it, altho' fire acts sooner on it, than on any other whatever; hence the force of fire is more universal than that of the air.

Let us now consider the air as fluid and heavy together; its weight presses *all around equally*, and this is easily evinc'd by a cylindrical vessel *A*, conical one *B*, a Jug-fashioned one *C*, on each of which a piece of paper *D* is placed, *Pl. 6. Fig. 2. &c.* each being first filled with water, and then holding your hand on the paper, and turning their mouths downward, the water does not drop out, which
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it would, if the air did not press against the bottom of these inverted vessels; and it enters into the surfaces of all vacuities in Bodies, as will appear hereafter; indeed it does not so readily enter as Alcohol or Oil into water; for invert a glass full of water, plunge it into Alcohol or Oil, you will plainly perceive each to penetrate and mount above the water; but air does not enter above the Quicksilver in the weather-glass; hence it is not easily dissociated; but however its effects are wonderful, for by its velocity and weight, it moves great Bodies, as appears in storms; it is also in continual motion; as will appear to any one that looks at a ray of air entering thro' a small hole into a darken'd chamber; for there you observe moats and atoms in continual motion.

The air is elastick; for compress it into what less space or compass you please, upon removal of that compressive force or weight, it returns again into its former space.

This elasticity is not observable in other fluids, *viz.* neither in Alcohol, Oil, Water, Spirits, nor Lies; for they are not to be compressed.

The density of the air then encreases, as the weight that presses it is encreased; so if 2112 lb weight presses a cylindrical tube of air, so that the tube is full 4224 lb, 'tis $\frac{1}{2}$; with 8448 'tis $\frac{1}{4}$; with 16896 'tis $\frac{1}{8}$; with 33792 'tis $\frac{1}{16}$; with 67584 'tis $\frac{1}{32}$; with 135168 'tis $\frac{1}{64}$; with 260336 'tis $\frac{1}{128}$ th part full only: it is not easy to say into how much less space it can be compressed, for air reduced into 1024 less space than 'tis by nature, it would be equally dense and as heavy as water.

And as 1000th part of the air is either Water, Oil, Salt, Spirit, or some other solid corpuscles, when the air is highly compressed, it comes to these which cannot be compressed, and therefore it

it hardly can be compressed so far as into 1000th part less than its natural space.

'Tis easy to reduce the air by double weight into a space doubly less; and the incompressible corpuscles in this case could not be observed; and as we proceed in compressing more, this difficulty will encrease upon us; for as fluids press upon the bottoms and sides of vessels, according to their heights, the tubes must be strong to bear the reduction of the air into a $\frac{1}{1000}$ th of its natural space; moreover you know this pressure enlarges the vessels themselves, especially Glass, which is necessary for such observations, since we can't see without a pellucid tube, now a very high tube is requir'd, that won't dilate, and that is pellucid, and how can such a one be found; moreover the heat must be equal in its temper.

I will now shew you how this properly was found out; Mr. Boyle took a Glass-tube *AB, bc*, Pl. 7. Fig. 1. which was crooked and had two arms open at *A*, and shut hermetically at *c*, every where equal in breadth in *bc*; 'twas strong Glass, the arm *bc* was 12 inches long, divided into lines, the other leg *AB*, many feet long, then by putting Quick-silver into *bc*, the air was condensed from 48 to 3, or from 16 to 1, and he found that the air was compressed, as the weights were encreas'd. *V. Boyle* against *Linus*, and *Marriotte*, p. 151. 154.

I don't remember to have heard, that any one has compressed the air into above $\frac{1}{16}$ of the whole space; indeed Dr. *Halley* and *Acad. del Cim.* do affirm, that it cannot be compressed further than $\frac{1}{800}$ th of its natural space, but then they have not published those experiments upon which they founded this assertion; this however is certain, that compress it as much as you please, it still expands itself in proportion as you take off the weight, and *Richard Townly*, Esq; said this held from

from 1 to 32 ; but we are not to infer farther than we know ; we know then our air can be compressed into 16 times less space, we know it can expand itself to 32 times more space than its natural state : This condensation depends upon compressing weights ; next this expansive force still remains in proportion as you lessen the weight compressing ; again after rarefaction, upon taking off the weight it can be compress'd again ; and, as far as we know, this rarefaction and condensation answer to the decrease or augment of weight : Now the *Italians* and *English* say it can't be compressed into a narrower space than 800 times, therefore their *conceal'd Arcana* have taught them this truth. Then the spaces it possesses are reciprocally as the compressing weights ; then this holds both in natural and compressed air ; next, Mr. *Townly's* proportions are not altered from 32 to 1, and, 'tis probable, the same rule holds in all degrees of compression ; but this compressed air does not pass thro' the glass for all the weight laid on.

Another law is the air's undestroyable elasticity, neither rest nor weight destroy this property ; *Marriotte* and *Boyle* kept air compressed in a Gun, and *Roberval* kept it shut up so for 15 years, and yet it was elastick as before ; and detain'd in solids and fluids for long spaces, it still is elastick, as may be try'd, and as I found in hartshorn kept for 50 years, which shewed in distillation plain tokens of this truth ; perhaps this elasticity exerts itself, when two parcels of air touch and repel each other.

Notwithstanding its density, it still remains fluid ; for as this holds true from 1 to 520,000, we may believe the air never grows solid with the greatest cold. In this elasticity of the Atmosphere, the greatest paradox is, that a small
portion

portion of air will effect what the whole will; for in a weather-glass shut out the air, and yet that small parcel at top makes the mercury rise or fall, as if the whole Atmosphere wrought upon it; exhaust the air in this tube, the Mercury rises to 28 inches. See Mr. Boyle, *Exper. Mechan. T. 1. Part 2. from p. 1. to 24.* If then a small portion of air acts thus, what effects may it not produce in chymical matters, where fire is often shut up, and the air is highly rarefied, vessels may be broken, &c.

This elastick force is encreas'd by heat, and acts as much as it does by its weight; for as in the weather-glass named and shut up, the elasticity lifts up the Quicksilver, as much as if the air had become denser; Thermometers and Barometers inform us of this: So Chymists must know that dreadful effects are produced by this fire.

Drebbel's Thermometer informs us, that the air does the soonest rarefy by the heat of any other body, and its measure of expansion is so great, as never to have been discovered hitherto; boiling water expands it to $\frac{1}{3}$ d of its bulk, and in a fire where iron is smelted, its expansion is prodigious. See *On Fire*.

In the same density of the air, the expansions are proportionable to the heat applied, *Ac. R. Sc. 1699, p. 113. and 1702, p. 1. 5.*

The denser air is by compression or otherwise, the more elastick is it; so that a small fire, when the air is under this state, may produce prodigies, if at the centre the air were pressed into $\frac{1}{800}$ of its natural bulk, a small fire would blow up the earth, if air were condensed 800 times more than it is, it would lift the Quicksilver up 29600 inches high: If then the air's weight and its heat are both encreas'd, the elasticity will be in a compound ratio of these two; on the
con-

contrary, the rarer is the air, the less elastick is it; an air doubly rarefied requires a fire doubly larger, to make it more elastick; hence at the top of the Atmosphere, no fire almost will encrease its elasticity.

Air is condensed by cold, as by a weight; *Farenheit's* Thermometer prov'd this; of which before.

In short, the Atmosphere warm'd to 46° , in *Farenheit's* Glass, if it be warm'd to 166° , its heat is of 212° , which boils water; then the air is rarer by $\frac{1}{3}$ d of its bulk, according to *Amon-ton's*; hence air warm'd to 166° , expands it one third more; add 40° of cold to 212 , that is 152° , which is the middle distance between boiling water and the greatest known cold; here the air is condensed to $\frac{4\frac{2}{3}}{8\frac{3}{5}}$, or near $\frac{1}{2}$; suppose the air to be hot to 90° , which is not common, it appears then, that the greatest heat and greatest cold encreases and lessens the density to $\frac{1\frac{5}{8}}{5}$, or $\frac{1}{5}$; hence observe what changes is made naturally in the air's density, whence as *Mr. Boyle* observes, the air's density may be determined to grow from 1 to 520,000, and to contribute to intestine motions in fermentation and putrefaction.

Lastly, This elasticity can't be destroyed by fire itself; let a Glass-globe be held in a furnace so as to be ready to melt, close it hermetically, let it cool gently, plunge it in water, break its neck off, the air rushes in with violence; and this may be brought to a *calculus*, by weighing this globe when full of water and of air; hence Chymists may know how to manage their materials when filled with air: from all which it may justly be inferr'd this elasticity is so proper to the air, that nothing can destroy it.

Having thus considered the air's properties, we come to view what a chaos it is, since it contains
all

all sorts of Corpufcles ; Firft there is *Fire* in it, as I have faid above, and I have found by the Thermometers, even in *Vacuo* ; no bodies attract it more than others, but all do contain it alike, and it is diftributed equally every where, nor are there any Magnets of *Fire*. Secondly, There is *Water* in the *Air* : Do we not breathe out *Water* every moment ? Did not *Sanctorius* prove a perfpiration, which is moftly *Water* ? Does not every body exhale *Water* ? Don't plants exhale it ? Has not *Mr. Hale* in his *Statics* of *Vegetables* prov'd it ? Don't *Water* exhale from kitchens, laboratories, or the *Earth* ? Does not the *Mediterranean* afford, according to *Dr. Halley*, 52,800,000,000 hogfheads daily, by the fun's heat only, abftracting from the winds ? What muft be done when winds are fuperadded ? Does not *Kruque* compute that about 30 inches of *Water* fall yearly on the *Earth* ? Hence muft fo much exhale : upon exhaustion of the *Air* in the pump, we fee the infide of the glafs grows ftreaky and cloudy ; fix'd falts testify this affertion by their flowing in the *Air*, two ounces, one dram of Salt of Tartar in three days moiften'd and weigh'd three ounces and a half and half a dram, its encrease of weight was then one ounce three drams and one half ; put the fame falt in a fcale, it weighs more every moment ; in fhort, it would weigh thrice its weight, were it to be long expos'd ; then 'tis called *Ol. Tartar per deliquium* ; diftil this and you get the *Water* and leave the falt. By this gentle folution of the falt the earth is more readily got from the falt ; and it is wonderful that it is hardly poffible to hinder this deliquation even in the warmeft place ; and fo far is it impoffible to hinder this fufion, that defigning to make an *extempore* tincture with *Alcohol* and dry Salt of Tincture, though I fhut

it up, immediately after its being poured out of the Crucible into a Mortar, and beat it there, in a dry, warm glass, and cork'd it and cover'd it with bladder oil'd, yet the Alcohol did not take a tincture, because the salt had attracted some Water.

In a Jug that wou'd contain 3 $\frac{1}{2}$ of Water, and shut up, an ounce of Salt of Tartar grows moist and heavier, hence this is to be added to the Air's weight, and if an $\frac{1}{850}$ th part is Water, then the whole weight of the Air shou'd be imputed to the Water in it, and perhaps but for this Water in it, the Air wou'd not be heavy at all.

Now either the Air must move constantly, and apply this Water to the dry salt, or the Water moves, or we must acknowledge an attraction in the salt and the Water towards each other; thus thinks *Sendivogius*, one ounce of salt attracts three ounces of Water, but three ounces of Water require two cubick feet and $\frac{1}{2}$ of Air to reside in; but it is most likely that all these causes concur.

But nothing is more singular, than that Water should attract the salt and make an oil of Tartar, which is as 7 to 5 to Water, and to Air as 1190 to 1, in which there is nothing elastick or aerial, but all it has attracted is Water: Hence in rainy weather, the Air loses of its elasticity.

There never is more Water in the Air than when it is a dry season, only in this case the Water is more equally distributed, whereas in cloudy and hazy weather, the Water comes lower; in the first case the weather-glass rises, in the latter it falls, as in Alembicks they are clear, whilst shut, but cloudy when open, from the unequal pressure, which there was before.

Dew

Dew, which is an exhalation drawn out of the Earth by the heat of the sun declining, for those steams which the sun drew up were clear, but that heat being lessen'd, the steams are not carried far up, for they cool and drop upon the herbage : It is a mere chaos and a mixture of every exhalable substance, and must vary with the soils that afford it, so that some has ting'd glass like a rainbow, which cou'd not be taken off; some has broke glass in distilling, some is like butter melting in your hand, and the like, so that its chief part is Water variously mix'd.

Clouds are Water collected, for when Water is lifted up on high, as in *Carniola*, which are 10274 feet high, at *Pic Teneriff*, which is the highest in *Europe*, or as *Maiguan* observ'd at *Toulouse*, there it is dispers'd, but when it appears in clouds, 'tis collected; and if the rain be divided into small drops, it is more resisted in its descent, by reason of its larger surface : *Showers* are always larger in summer, because as they fall they unite with others and form large drops, hence showers do come from on high, because they unite with many watry parts, so as to be large at last.

Fountains are generally in mountains, as may be seen in *Bernier*, on the valley of *Cachimir*, in the *Mogul's* country; but they arise from the watry parts distilling from on high. Rivulets spring from fountains, and rivers from rivulets, which run into the Sea, whence they only return by exhalations; where there are no Mountains there are no Rivers.

All Air has Water in it, which is verified so high as we can go, that is, in the mountains; and it might be possible for us to rob the Air of its Water by Salt of Tartar in a Jug, but this
I 2 wou'd

wou'd be of no use to us, since upon opening the Jug more Water wou'd rush in.

In the highest places, as mountains even under the Tropics, the Water grows cold, and unites into snow or ice, this we see how high mountains always have snow upon them; and the higher the Water, the more does it freeze.

When these particles unite, they fall into snow; and hail also is snow melted into globules and falling.

Thunder and lightning arise from the friction of those icy parts together, which when they fall low produce such stupendous noise and showers, and we see that hail generally accompanies great storms.

The Airs weight being diminished, by opposite winds, makes these storms fall.

The Causes that lift up these watry vapours are the sun by its heat greater or less, subterraneous fires, which make the Earth hotter, as we go deeper; kitchen fires, frost, air, all causes that divide Water into so minute Molecules, as that they grow lighter than Air; Lastly, Winds, as Dr. *Halley* has prov'd.

Let us now consider what the Air join'd to Water does on bodies; first it insinuates itself by the Air's action upon it into all pores and passages; the Air and Water produce volatility, as appears in exposing salts to the Air, then letting the Earth settle, and evaporating and drying the salt, and all becomes volatile, the same is said of fixt salts; whenever Water abounds in the Air, relaxations happen in bodies, and they ferment and putrify, by being thus let loose. Thus Plagues have happened; since then Water in the Air dissolves all salts, no wonder of all those appearances that depend on this solution.

Hitherto we have consider'd the Air as elastic, as containing Fire and Water, let us now consider the other bodies in it. The

The Air contains in it the scents of plants, which are dispers'd in it issuing from the plants; it also contains spirit of wine in it from the hogshheads that have been fermented; it partakes of spirits from the laboratories of chymists; it shares of Chimycal Oils; it contains all species of salts, as also contains earthy parts, foot, sand, ashes (*a*) of Volcano's, and also the seeds of plants, as may be gather'd from plants growing on towers, and the mosses and other small plants disperse their seed to very distant places: The ashes of a Volcano have been found a 100 Miles off, *Ph. Tr. N. 21. p. 377.* See *Marriotte, p. 334.* speaking of a cloud that dropt hail-stones, was carried fifty French Miles; our *Perspirabile* is also carried up and adheres to bodies and hunting dogs smell it, and it infects others; so are the excrements of animals and urine carried up: Thus whales cast up, lie and smell and infect places with their stench; so do horses, camels, and men after battles infect whole countries; so also do buried animals putrify and leave bones only behind. The eggs of some insects are also carried up and are hatch'd in the Air; I hung up a piece of flesh boil'd in Alcohol, then anointed with Oil of Turpentine, in the Air, it swarm'd with maggots, that eat up all the flesh; which cou'd only come from the Air: In *Egypt* rains fall, that strike the travellers with shivering, as also others fall that corrode their skins, and cloths, *Act Lip. 1. T. 1. p. 425.* As to fossiles these are also in the Air, and chymical spirits distilled or made by commixtures fly up: *Glauber's* method shews us how

(*a*) *Republ. Literar. T. 1. p. 590.*
Transf. Abridg. T. 2. p. 143.

Ibid. 1708. p. 152.
Ibid. T. 2. p. 141.

easily they are made to appear and evaporate, and there is a determinate stratification, so that they fly up and take up their abode according to their gravity. Sulphurs also fly up into the Air from bodies under distillation; as also from mines, and breed lightnings: Even metals themselves do mount into the Air; it is plain in Quicksilver, which flies off with a fire of 600°, and the same may be said of all the rest in the furnaces of metal-makers; hence also Silver and Gold do fly up, so Gold by sublimate and Regulus of Antimony turns into an Oil and mounts, and most metals are made volatile by Sulphur, Calcanthum and Sal Armoniac; so in the mines there are choaking steams, which may be metals reduc'd into this shape by various mixtures in the bowels of the Earth. Metals are by the Air chang'd into Vitriols and dust, and are carried up; the *Englisch* testify, that at *Bermudas* Isles, bricks and tiles are corroded. Marchasii are ripen'd by the Air; the dew that dy'd the glass like a rainbow, neither yielded to rubbing or Oil of Tartar, and yet it burn'd like Alcohol, this resembles the metallick tincture on glass. Hence Air is a mere chaos, that contains particles of all sorts, which produce such stupendous effects; hence meteors; hence various attractions and other Phænomena arise; if you hold spirits of Sal Armoniac and Nitre at a distance, they produce no effects, but as soon as you hold them together they smoak; an Amalgam of Quicksilver and Tin, distill them with spirit of Salt, they afford a liquor, which, when shut, don't smoak, but they afford a thick fume, if expos'd to the open Air, and they continue this effect for years. We know what some bodies will do, but we know not what species of them are in the Air; we see what Oil of Sassafras, and Glauber's spirit

spirit of Nitre does; thus may we explain Meteors and the like; how do we know what effects are produc'd from the aspects of the stars, from comets, &c.? Every Air differs as to its effects, which are peculiar to the place; Chymists expose salt of Tartar in their Laboratories, where they often distill vinegar, they get a *Tartarus regeneratus*, but they try it in vain where Vinegar was not; some places are inhabitable after earthquakes, inundations, &c. winds bring Airs from different places, and change the present condition of it. — Colds, heats, influence from the sun and moon bring vicissitudes of weathers. The sun in spring unties the frosty glebe, and exhales Vapours, and brings storms, thunders, rains, and it makes plants flourish; but tho' there be the same heat and weather in autumn, the plants decay. Diversities of seasons then effect different appearances.

There is one thing peculiar to the Air, that birds, or fishes, or eggs of animals, or seeds of plants, if shut up close do die, or don't grow; Blood expos'd is fluid, but when there is no Air comes at it, 'tis black; happy he who can tell us news of this Cause! *Sendivogius* and Chymists say, there is a hidden Spirit of Life in the Air. This is not yet discovered.

Now we will speak of the *Airs Gravity*, the Water in the Air, as well as other bodies in it are all heavy, and were we to take off all heavy bodies from it, perhaps it wou'd not be heavy; for in a cubick foot of Air let the 850th part be all Vapours, then the elastick part wou'd weigh nothing; hence it might happen that it cou'd not be reduc'd into a less space than one 800th part; however, if these other mixtures of Incompressibles were absent, the elastick part of the

Air might be farther condens'd. The Air and Fire are created pure and not heavy, they are dispers'd equally and the Fire acts upon the Air. In the higher atmosphere, if the Fire be less, the Air is thinner, and a less Fire will boil things there, but it always produces a tumultuous motion, hence a perpetual motion; the Air is not so rare in the lower atmosphere, therefore it is heavy only from mixtures not of itself.

Behold *Marriotte's* experiments on the Airs elasticity.

EXP. I.

1. The Air sticks to bodies, for plunge polish'd silver into Water, you observe bubbles on the plate, which are Air that sticks to the pores of the silver, and when Spirit of Nitre dissolves silver, the bubbles are Air that stick to the surface.

EXP. 2.

2. Fill a glass with Water, suck out the Air, you see bubbles, these are only Air, that stuck to the surface of the glass.

EXP. 3.

The elastick part of the Air has some viscosity in it; fill a spherical glass with a long cylindrical neck with Water, invert it, the Water does not fall out; again fill the same Glass with a Lye of Salt of Tartar, plunge it in Oil of Turpentine, the last oil ascends, but slower than Water or Alcohol; fill two thirds of this glass, with any liquor, let the rest be Air, shut it carefully, shake them together, so that the Air and Water mix throughly, bubbles arise compounded of Water and Air; plunge this Glass full

full of Air into Water with its mouth upwards, the Water does not enter, but is sustain'd, altho' 850 times heavier; fill this glass full of Water, invert its neck, a bubble enters, pretty large; plunge a Tube open at both ends into Water, the upper surface is concave; all these shew that the Air has some cohesion and is not easily divided.

EXP. 4.

Take three vessels, *Pl. 8. Fig. 1.* A, B, C, in one is cold Water 44° as hot as the Air, another heated to 91° , 9° , 3d to 150° , place them under the Pump, exhaust the Air, the hottest C bubbled up soon, the next hottest in B soon after bubbled, but in A it bubbled last; hence it is evident that the elastick Air resides in Water, that is, in its interstices; compression keeps them there, and rarefaction draws them out; hence inflammable spirits afford Air soonest.

Fill a Cylinder, *Pl. 8. Fig. 2.* AB half full of Water; fill CD full of Water, put your finger on D, plunge it into AB that no Air enter; put these into the Air-Pump; suck, the Water in C descends by D into AB, because the surface of the Water in AB is no longer press'd upon by the weight of the Atmosphere; and is in Vacuo. The Water then is in Vacuo, for nothing presses it: the Air is exhausted from CD. I leave all in this situation till the Bubbles appear no more, nor ascend into AB. Let in Air, it presses upon AB, and forces the Water from D into C; the Air being let in the Water fills not now the whole globe C, but there is an elastick bubble at C. These bubbles were not made, till the Air was exhausted, so long as $\frac{1}{10}$ of the Air is not exhausted; now as the Air naturally is never more than $\frac{1}{10}$ exhausted, the Water then never can lose its Air;
nay,

nay, Water heated to 90° , does not bubble in the Air-Pump, therefore nor will the blood lose its Air in such a case : I say the Air at top is elastick, because it contracts by cold and expands with heat.

This Air comes from the Water ; we see how fermented liquors, Alcohol, Quicksilver, &c. differ in the quantities of Air they produce in the Air-Pump ; and this waste by the separation of it from them : Oil of Tartar binds little, nor spirit of Sal Armoniac, all is resorb'd into the Water again. Nay, it is evident, that the Air exhausted pre-existed in the liquors, or fluids, you exhausted it from.

EXP. 5.

If Water be void of Air, and cool'd to the temper of common Air, the elastick Air, by exposing the Water, enters into this Water so exhausted of Air again. Do as in the 2d experiment of the 4th Title and experiment ; if then we compress, this bubble does not mix with the Water, but expose the Water to the Air, and it mixes, and the same Air enters the Interstices of the Water as before : but more than the Water contains naturally will not enter ; as I have try'd with a bubble I admitted, as in the last experiment, which never would mix with the Water : the Air from a small bubble is suck'd equally in, and is equally dispers'd through all the Water. *Staire* in his *Phys. Exp.* p. 572, supposes these Bubbles to be Fire, and not elastick Air.

EXP. 6.

Air is separated from Water by boiling ; for, take AB, *Pl. 8. Fig. 3.* fill it with Water, put in it a Tunnel CD, plunge it quite in the Water ; take EF,
put

put it upon CD, first having fill'd it with Water, and by your finger stopp'd the entrance of any Air, boil the Water and you see the bubbles go out up to F in EF; as for the bubbles rais'd with Explosion, those are Fire, and they don't generate Air, for the Air comes out quietly and settles in a bubble at F; now let all cool and these bubbles enter the Water again. I try'd Rain-Water, boil'd it, try'd it as in the 4th experiment, exhausted the Air, no Air was at the top of C at first, but some days after it appear'd there; I thought the Air stuck in the Water and would not appear by boiling, but afterwards it was separated, or that the Water was changed into Air.

EXP. 7.

Frost separates Air from Water, for as the Water freezes, it swells, and bubbles appear every where.

EXP. 8.

Fixt Salts running *per deliquium* shew no Air in them, whether you boil or exhaust, or expose it to the cold.

EXP. 9.

I took Urine just as 'twas made and 90° . hot, I exhausted till the Air was exhausted to 27 Inches before it mov'd, then it boil'd, I also try'd Lyes with Salt, Sal Gem, Nitre, Sal Armoniac crude and volatile, Quicksilver.

Cor. 1. Hence Air is attracted into the void spaces of liquors, into which it insinuates itself.

Cor. 2. It is dissolved into its component parts in these liquors.

Cor.

Cor. 3. But this Air is a very small portion of the whole.

Cor. 4. And these liquors having imbib'd a certain portion, never admit of more by any method.

Cor. 5. Water impregnated with salts, does not dissolve Air.

Cor. 6. A solitary particle of Air, separated by the Water is neither elastick nor dilatable by heat, so like a Magnet when separated from another does not act, nor likewise the Air.

Cor. 7. But when this separated particle approaches to another, then it shews its elasticity by bubbling.

Cor. 8. And it acquires its own properties gain, and in mounting meets with its like, and unites into one large bubble.

Cor. 9. Salts don't attract this Air.

Cor. 10. In every liquor known there is a determined quantity of Air.

Cor. 11. 'Tis a doubt whether the Air in the malpighian Ducts of plants be the same as common Air.

Cor. 12. The Air contain'd in animal juices is not the cause of putrefaction, which requires the common Air.

EXP. TO.

The Air in Water seems to take up a small space, but exhaust it, and we find it takes up more space than Water itself, which is thus prov'd.

Place the Cone *Pl. 8. Fig. 4.* FC perpendicular in the Copper square AB; fill AB with oil till it cover FC, then put FC in the position F; then will it be void of Air, but full of oil; then boil the oil in AB, till it crackles no longer; then the oil will be free of Water and Air; let all cool; then

then by a glass tube convey a drop of Water down to C, which is a hollow made to hold Water; place then the vessel D upon the hollow C, to cover this drop of Water, then the Cone will be void of all Water and Air; then clap the flame at G to the hollow thimble at C gently, the Water will throw about its Air contain'd and occupy a great space, by which it often throws up the conoidal Thimble; let all cool, then the Air under C will be contracted; you see then how the Air expands itself upon exuction or heat. The Air in Water is not such a fluid, as when freed from it.

The Air in liquors does not act as the Air without; hence *Borelli* is mistaken who talks of the oscillation of the elastick within us (*b*). We see then that Air join'd to bodies takes up less space then when collected from them.

The Air acts by repulsion when united, and expands itself; Air when united to bodies can pass the minutest pores, but when united to itself it finds a difficulty to pass and enter, and Air easily enters into liquors depriv'd of it by exhaustion, but not into those that are already full. Hence may it be inferr'd, that the Air in liquors does not act as common Air, for let a vessel be full of any liquor, then the pressure encreases as the height; hence there is no pressure at top, the Air gives no tokens of pressure, no bubbles appear, &c. Separate the Air, then it acts, and shews all its properties; hence in our blood it acts not as Air, and never raises bubbles; and tho' heated to 92° . yet it exerts not itself; therefore it acts not as Air.

(*b*) The Professor forgets how bottles crack; and contradicts himself elsewhere.

Here

Here I shall subjoin an Experiment to shew you factitious Air; I put Crabs eyes and Spirit of vinegar into the Air-Pump and extract the Air to $28\frac{1}{2}$ Inches; then I pour the vinegar to the powder, by a machine contriv'd, they boil up, the Quicksilver descends 12 digits; the recipient held 7 l. of Water, the heat was 52° , hence this factitious Air, capable of filling 114 cubick feet with Air, which was to the Density of the Atmosphere as 24 to 57; therefore Air was produc'd in equilibrio with the Atmosphere which fills a space fit to receive 48 oz. of Water equal to 81 cubick Inches, supposing a cubick Foot of Water equal to 64 l. 1st. The ebullition was stronger than if it had been try'd in the open Air, hence pressure adds not to this action. 2dly, So much elastick Air is bred thus, as to fill 81 cubick Inches, and which can resist the pressure of the Atmosphere. 3dly, So much Air cou'd lie conceal'd in bodies without Action; 4thly, This Air has not so much weight as a vaporous Air; 5thly, What wou'd happen to us if such bodies shou'd meet in our vessels; hence I suspect such effervescences can't happen within us, because so much Air wou'd be bred as to blow us up: Lastly, There is great danger from a vacuum in our vessels, shou'd it happen; I try'd the same with chalk, the same happen'd, the Mercury descended from $28\frac{1}{2}$ to 6; so as to fill a space capable of holding 90 oz. of Water, that is 151 cubick inches. I mixt also oil of Tartar with the spirit, a great ebullition ensu'd, whereas in open Air 'tis gentle, as you see when I prepar'd *Sal Sennerti purg.* and yet there is no Air in Salt of Tartar deliquated; and $\frac{1}{4}$ of the Alkali of Tartar saturates vinegar; what wou'd happen to us, if there was such a vacuum in our vessels, and such effervescences shou'd happen? but

in pleno there's less danger; no Air is requir'd to these effervescences, nay it hinders them; 'tis then an innate property in bodies that causes these effervescences, and the Air is separated by their action.

Take 4 ℥ of Oil of Tartar and 3j℥ of Oil of Vitriol, put them into two glasses, exhaust the Air, the oil bubbles, but not the salt, mix them they boil vehemently, and rarify so much as to take up above 12 times more space, than naturally, the Barometer sinks from 20 to $12\frac{1}{2}$, hence all the Air is not extractible till the ebullition commences, some of it then adheres to the bodies till their commixtion, attraction and attrition disengages it; the salt settles dry to the bottom, and the Water swims at top; I have often consider'd whether this Air was natural, or chang'd and resembling the natural Air (c).

Spirit of Nitre exhausted does not bubble, but smoaks upon admission of the Air, which Oil of Vitriol does not; put into the spirit, in the exhausted Air-Pump, a little filings of iron, a strong ebullition ensues and a fulmination, but which does not sink the Mercury so much as expected; the ebullition ceases upon readmitting the Air, hence Explosions may arise without a proportional production of elastick Air.

In the Philosophical Transactions (d) there were put 3℥ of Spirit of Nitre and 3j of chymical Oil of Caraways into two separate Glasses in the Air-Pump, the Air was exhausted and the liquors mix'd. In an instant the glass was lifted up into the Air, and the liquors flam'd, which weigh'd 468℔; the Air produc'd and the

(c) This last is a weak difficulty, for this Air is only struck out of the Cells that held it by attrition.

(d) No 213. p. 212.

expansion wrought together ; tho' this experiment be dangerous, yet the force might be computed by enlarging the glass, till it fail'd of this effect.

I shall add the last method of producing Air, *by Fire and Agitation* ; thus fermentation, putrefaction, distillation, burning produce Air ; liquors fermenting burst barrels ; if in distillations there wants room, the vessels crack, as in distilling crude Tartar ; so long as Air is entangled in bodies, it does not act, but as soon as 'tis let loose, it proves elastick. See Mr. Hales's vegetable Staticks.

Of W A T E R.

Water is the most common of all the elements, and its use is general, yet its nature is the least known, because we can't separate other bodies from it, or it from others. Hartshorn kept for half an age will afford Spirit, Oil, Salt and Wa-

(e) By way of an appendix, Chymists are always to bring the Air and its effects into the account, because all bodies that are handled chymically are expos'd to it. First, It presses all bodies, and insinuates itself into them ; 2dly, It joins in with them, and loses its elasticity and fluidity ; 3dly, It mixes all bodies together ; which, in a vacuum or high places, does not happen, for you cannot make the Soap of Turpentine, nor dispense Salt of Tartar *in vacuo* ; 4thly, It puts bodies in action, so Corrosion is not made in vacuo, v. g. Spirit of Sal armoniac does not corrode Brass in exhausted receivers ; if the Air be any heavier, Water does not boil so soon, Diamonds act not without application and motion ; Papin's digester, does not dissolve Bones without fire apply'd ; attrition is requir'd to produce heat : 5thly, It suffers no body to be at rest, and is always changing as is seen by the Barometer, hence neither fermentation nor putrefaction happen without it ; 6thly, It contains all sorts of particles, which serve as a menstruum to all, and may be called an universal menstruum, it produces Colours and destroys them, it fixes and renders volatile, &c. Observe then the state of the Air, whenever you make experiments, Camphire in an open Air flames and has a sooty Smoak, in a vessel defended from the Air, it mounts and grows purer ; Sulphur in a close vessel, is always Sulphur, but in the open Air, it turns into Flowers, and an acid Spirit. So much on Air.

ter ;

ter ; stones themselves yield Water ; put clay dry'd in the sun to dust, it is made a paste with Water, which is ductile and will by Fire turn into stone ; the Air contains it, as I have said, and confirm thus, ice in summer, or your hand will smother ; pour Water into a glass, the glass is dry, mix a little Sal Armoniac powder'd, close the glass, a dew is seen on its surface, from the Air chill'd ; our breath smokes in winter ; hence the Air has Water in it ; if Water is not more readily separated from other bodies, than from the Air ; most bodies are held invisible in Water, and 'tis hard to get it sincere.

But we must describe Water, so as to distinguish it from other bodies ; therefore 'tis described fluid, without smell or taste, clear, without colour, and freezable, this is its description, and whatever answers not this description is not Water.

It is always full of Fire, where that leaves it, it freezes, see at 32° , but if its heat be lessened to 73° , still *Alcohol* freezes not with so much Fire abated nor Mercury : Water at 32° to Water as warm as our blood, differs less than at 30° of cold, that is, it is as 58 to 73.

Water abounds with Air and is defiled with all its various particles, Rain-Water testifies this. Air in Water is hard to separate, since the weight of the Atmosphere must be taken off, e'er you can separate the Air in 33° of heat ; and heat requires 150° before it can, in an Atmosphere of middle weight, separate the Air mix'd. Hence the greatest heat in our Air and the highest Atmosphere can't separate the Air from Water (f). Next Salts seem to expel it, but then they fill the

(f) Not the whole indeed, but some is exhausted naturally, or liquor expands in proportion to the external Air.

Interstices; and we have reason to believe, that the Oil of Tartar does not in Vacuo dismiss its Air, because it attracts it strongly; and when fixt Salts are near drying by evaporation they swell and attract the Air, which they scarce part with afterwards, unless by a mixture with acids. Water seldom settles without Air and its contents; let us see now how to get Water pure and sincere, to do that we must view its properties.

As to its gravity, it is hard to determine it, some bodies Alcohol, chymical Waters, &c. are lighter, whilst fountain, river, and Well-Waters are heavier, from their contents, than natural Water, some are vitriolick, saline, bituminous, &c.

Well-Water arising from a sand-bed, is pure Water; this Water is called *living Water*, because if you dig below this sand, whence it issues, more sand comes in and fills it up; now sand is angular pieces of flint, that always leave space enough for the Water to issue out; if this Water be laden with salts, or bitumens, &c. as the earth is a chaos, then that Water will be impure, otherwise this Water is to gold as 250 to 4909, or as 1 to 19 and $\frac{159}{250}$, or 20, and to Air as 850 to 1, a cubick inch of which weighs 252, 256, 260 grains; to crystal 'tis 1 to $2\frac{10}{9}$, to marble as 1 to $2\frac{7}{10}$; observe the heat of the Air at the time you compare the weight, for that makes Water lighter; Water rarifies more than metals or other bodies, and therefore observe this caution (g). When two Waters then weigh differently, the heavier contains somewhat heterogeneous; and will be dan-

(g) Pray does not every body rarify with heat as well as the Water, and in the same proportion? For if Water is made $\frac{1}{20}$ lighter thereby, gold will be warm'd to the same degree, and then the difference still keeps the same pace, v. Cor. 5. 82. of Exp. 10. on Fire.

gerous

gerous or of use ; the lighter, the better, if no spirits are contained ; *Hippocrates* commends Waters the best when they boil soonest, and among those Well-Water ; and *Herodotus* says, that in *Egypt* even wood settles and that they live long there ; we have none such, therefore their wood must be heavy, such as are the *Sideroxyla* or iron-woods, our box, our oak, Guaiacum, are heavy, and we may give credit to what we can't contradict ; our Water is heavier than wine or any fermented liquors.

Water is *fluid*, rises in dewy vapours, and descends in Water, not in striæ as oils and spirits ; and any heat evaporates pure Water, but Water mix'd with salts not so readily ; Dr. *Halley's* computation of Water flying off by heat or winds in the *Phil. Transf. N. 189. p. 366*, which I have also try'd myself ; and *Kruque* also observ'd, that rain, snow, hail and dew will exhale ; so that the sun and winds do exhale Water, hence 'tis moveable and divisible into minute parts : This property depends on Fire, for at 32° it freezes, but at 33° 'tis fluid by our Thermomiter, so that 33° degrees of Fire keep it fluid, but 32° only make it freeze.

But that cold decreas'd, in the hard frost at *Dantzick*, as was said on Fire, from the 33° to the 31° naturally ; and heat never encreases naturally to 80° ; hence it is evident, that Water becomes a lasting ice within $\frac{1}{3}$ part of the greatest natural heat, and the other $\frac{2}{3}$ 'tis Water ; and there must have concurred a great cause, that required a necessity in the nature of things, that Water, to be Water in that degree of heat, should turn into ice so soon as the heat was lessen'd below this degree.

This fluidity cannot be encreas'd, encrease the Fire how you please, for 'tis either the same

Fluid, or Ice, there is no middle way; and Sir *Isaac Newton* demonstrated in his *Opticks*, p. 312, that the vibrations of the pendulum in cold and scalding Water were equal (b). But this is only understood with regard to our senses, doubtless Water grows lighter till it comes to 212° by heat; however this alters not the motion of the *Pendulum*, since the resistance is here only made by the *Vis Inertiae* or density, and not the attrition or tenacity.

Its compound particles are so small as not to fall under the notice of our senses, they even seem to be less than those of the Air, since they penetrate leather, which Air could not; however as Air enters the Interstices of Water, I question whether those of the Air be not less than those of Water, so from penetrability to magnitude there is no argument can be drawn, neither can we discover its competent parts by our senses.

Mean while altho' we cannot measure the smallness of the elements of Water, yet we truly know that there is no fluid who's parts are more penetrating than it, let me except *Fire* which penetrates all bodies, and the *magnetick virtue*, if by chance you should think that this acts after the manner of a liquor upon magnets and iron. Lastly, *Light*, if this is supposed to differ from *Fire* itself, and to resemble the nature of liquors, then I will ask natural philosophers if they can shew me any liquor that passes thro the impervious pores of Water, *ceteris paribus*. I know indeed that oil sometimes will pass thro' wooden

(b) Sir *Isaac* speaks of resistances, and that from attrition or tenacity he computes as a *product* under the diameter and velocity of the sphere; but that from the *Vis Inertiae* or density of matter, as the square of this product, for ex. $3 \times 2 = 6$, and $6 \times 6 = 36$, and that rarer mediums resist as the *Vis Inertiae*, wherefore he does not absolutely say, that heat does not encrease the fluidity, but not much. vid.

casks in which there is Water contain'd; but when the oil dissolves oil and resins, and both being dissolv'd flow out, where the Water does not dissolve the resinous parts of the oil, it is retained within the vessels; we see that Water does not pass thro' paper wet with oil, thro' which oil easily passes; hence also it comes to pass, that the thicker liquor of sugar turn'd into syrup passes sometimes thro' wooden casks, which however keep back the Water; for sugar diluted with Water is a Lixivium, which by virtue of the soap dissolves the tenacious parts in the wood in which the Water is shut up; hence also Saline Lixivia, I speak chiefly of alkaline fixt salts, can hardly be kept in wood vessels, in which pure Water is kept without transuding; hence Water is known to be the most penetrating, and most fluid of all liquors (i).

Metals extended into plates, jewels, flints, hard stones, glass and sulphurs cannot be penetrated by Water, neither can hard ponderous and resinous woods be penetrated by it; indeed, soft, light, watry and saline woods do admit entrance to it; also porous stones, earthen ware, bricks and common cement of lime and sand, Porcelain vessels, and cements of chalk stones, tho' dry'd to glassy substance, do admit of Water; but glass is no way chang'd nor penetrated by it: for *Clavius* put Water into a glass, seal'd it up hermetically and mark'd it with a diamond how far the Water reach'd, and this was found full in *Kircher's Museum* 80 years after as it was at first.

(i) This paragraph contradicts itself in every article; for if he means *penetrabilior* more penetrating, then Fire, magnetical force, and Air are more penetrating.

He generally in his whole Treatise takes this word in an active sense, therefore why does oil, sugar, &c. pass, when Water does not?

If Water cannot pass thro' any body not fusible by heat when closed up, then neither will it pass by the help of the Fire, this we are taught by chymical experiments every day, this *Clavius's* experiment shews us, this *Papin's* Digester for softning bones, this the great *Æolopile* full of Water and thrown into the Fire shews us, which only passes thro' the small orifice; and *Stahl* believes that Water by heat may be so attenuated as to pass thro' the glasses; but this he cites upon others credit, and there is a great difficulty of cementing the glasses so that it shan't pass thro' the Lute. *Becher* affirms, that by repeated distillations it will become corrosive; however I've never seen any signs of this penetrability or acrimony. I have been often convinc'd that nothing is more difficult in chymical operations, than to take care that nothing is lost, or nothing new mixes with bodies.

Pressure itself will not make Water to pass thro' the vessels, not even in *Papin's* Digester; the same was formerly tried in this hydraulick machine ABD, it consisted of a hollow cylinder AB made of brass and solder'd every where, and shut up only at B. Into the tube BC, which was then at C 6 foot high, it ascended to D, so that there was a communication betwixt AB and A BCD; and there was at A a small tube E a little higher than A F. In AB thro' which the liquor from AB could be retained or let out, when then the Water let in thro' DE being open had fill'd AB, then E being shut the Water was pour'd thro' DC which pressed the Water in AB so strongly, that this vessel was so distended, that the copper plate A F was press'd outwards, and

(k) How can Water be colder than Stones, for all partake of the same Air; and are heated and cool'd alike. and proportionably.

lifted

lifted up, altho' a great weight was put upon it, yet not a drop of Water came out; but when the Water was put in at D, the folder was broke and the Water flow'd thro' the chinks; hence 'tis plain, that Water pressed with the greatest force cannot be pressed thro' passages, which it does not pass of its own accord by its own tenuity. *Plate IX. Fig. 1.*

The *Academia del Cimento*, in the experiment which they try'd in a globe of metal, thro' which the Water passed by pressure, seemed to contradict this assertion where it passed thro' the pores of the metal; but a sphere which is greatly pressed has its pores enlarged, and the Water passes thro' 'em, which when the pressure ceases grow less again.

We know then that the elements of Water cannot be more encreased than by Fire, nor more lessen'd than by cold, and this diminution reaches no further then 32° of heat, for then Water is no longer Water, but ice in which bubbles are formed, and the particles are enlarg'd; hence we understand a paradox, which plaisterers say they have observ'd, namely, that Water the colder it is pierces thro' the walls more fiercely, but less when heated, it appear'd above that Water is more condens'd by cold than stones, hence it may be that cold Water can pass where hot cannot.

Hence Fire does not lessen the elements of Water, but extends its bulk, and there is the end of the power of Fire upon Water. I've distill'd rain Water receiv'd upon astronomical glasses, and kept it for many years, and found it always to be the same, whether hydrostatically or chymically try'd.

But as 33° of heat keep Water fluid, we know it is always mov'd by this Fire, 'tis this Fire that

makes ice into Water, 'tis this that occasions the solution of salts, which some attribute to attraction, Water has always a tremulous motion; and our microscopes discover a motion in it.

The elements of Water are unchangeable, and this is true, whether you consider them apart or join'd into a mass, for its figure returns, as also all its other properties after any operation whatever; if it chang'd its figure, its other properties would be changed; suppose its elements were spherical and it should become cubical, then the spaces between wou'd be larger and it wou'd be lighter; in the *Æolopile* the Water is agitated, but this vapour being receiv'd in a vessel, 'tis Water again.

Whence 'tis not as *Cartesius* and *Staire* affirm, compos'd of particles like eels, they are not indeed flexible, but hard as diamonds and spherical; for if a globular particle of Air should stick in the spaces, the space of Water wou'd be to the space of Air, as 100 to 7, or 14 to 1, as *Kruque* computes.

Water is not compressible, as has been try'd by the *Acad. del Ciment*. *Du Hamel* says the same; but *Colbert* tells us, that a sphere of lead fill'd with Water could be compress'd; and *Bacon* says, that a tin globe full of Water compress'd strongly, the Water let out at a hole and boyl'd, says it spouted out three feet in length, and *Staires* affirms it; which last seems to destroy the opinion of the *Florentines*: but two things are to be consider'd, 1st. The Air may enter and hide itself in the liquor, which being compress'd it will flow out at any place so long as that Air does not expand itself to an æquilibrium with the Atmosphere: 2^{dly}, Metallick parts may suffer a breach from whence the Water may flow, but the *Florentines* took off these objections.

Q. ? 'Tis wonderful that the compression of the Atmosphere does not alter it's density ; 'tis therefore wonderful that the author of nature shou'd make one element elastick and the other not so ; there is a necessity for great caution in these trials, and no Air shou'd be shut up but what the Water contains, then we must carefully mind that the heat be the same all the time of the trial, because that expands the Water. 3dly, You must take care that the Air contain'd in Interstices of the Water be not elastick, we must therefore observe that there be no bubbles in this Water.

We next consider the simplicity of Water, which is found in every particle to be alike, unchangeable in all its properties ; hence the Alchymists supposed all things were made of Water ; hence *Paracelsus* and *Helmont* inculcate the same ; and hence they said, that all things could be return'd into Water ; but this is not reveal'd to us by experiments ; for after the ancientest of all authors, *Moses* had deliver'd to us, that the spirit of God had breathed upon the Waters, and imbued all bodies with their virtue ; the *Phœnicians*, *Ægyptians*, and *Thales* broached this opinion, which the Chymists receiv'd. The *Helmontians* acknowledge two simple bodies only, pure Water and Quicksilver ; and some affirm Mercury to proceed from Water, because 'tis at last resolv'd into it ; hence they esteem Water the universal nourisher of all things, which nothing can change.

The next property is, its *mildness*, for if Water be reduc'd to the heat of a human body, and apply'd to its tendinous parts, it makes no impression ; if you apply it to the Canthus of the eye, it gives no trouble, or to the nostrils, it produces no troublesome sensation, or to the
nerves

nerves inflam'd, or to ulcerated places, it gives no torment; if you foment ulcerated cancers, or nerves that are bare and half burnt, you ease the pain, 'tis even milder than oil, it mitigates the acrimony of salts, for take a dram of Vitriol, drink upon it ℥vj of Water it hinders the effect of this poison; it is then without taste, smell, or colour; wherefore Water is adonyne.

- The next property is, that it dissolves bodies and makes them fluid; *1st*, For example, it dissolves fossil salts, as Sal Gem, Sea Salt, Borax, Sal Armon. and Alcaline Salts; as also Acid Salts or Spirits, as Alum, Oil of Vitriol and Spirit of Sulphur, these three acid spirits differ little from each other, and are seldom found under a dry shape, having in them a power to attract the Air, as also Spirit of Nitre, and Sea Salt, which two are always liquid; these acid salts can be dissolv'd in any quantity of Water ever so little; for take a pound of Oil of Vitriol, the elements will be so mixed, that the whole quantity of oil will be dissolv'd in it; the same can't be said of dry salts, where Water dissolves only a certain portion of 'em; however, once you have thoroughly dissolv'd them, they may be further dissolv'd in any quantity of Water, dissolve ℥j of Sal Gem in three ounces of Water, add but one ℥j of Water, and the whole Lixivium will be dissolv'd in this quantity: This is an odd property that each particle of Water shall have its share of salt; you may observe, that concussion performs this solution sooner; *3^{dly}*, Warm Water performs this solution sooner than cold, so that cold Water to 32° dissolves slowly; but at 212° dissolves them presently, and when you have dissolv'd bodies in warm Water, part of them will subside when it cools, so that when Water comes to freeze, it expels all

all these salts; as salt hinders Water from freezing, so the same sprinkled upon Ice, will thaw it; hence sea water seldom freezes; *4thly*, Crystallization is made for want of Water by rest and cold. *5thly*, We find this power to exert itself upon one salt sooner than another, so that Sal Gem is sooner dissolv'd than Borax, and the Water will receive more of it than of Borax. *6thly*, When Water has dissolv'd a certain quantity of any salt, till it will receive no more, yet still it will dissolve more of another salt; suppose you dissolve as much Sal Gem as it will hold, put in Salt-petre till it will not be dissolved any longer, it still will dissolve a third and a fourth.

2dly, Pure Water dissolves metallick or vitriolick salts, as Alum, Verdigreese, &c. *3dly*, It dissolves vegetable or animal salts, whether they be acid, neutral, or alkaline; but Tartar is the hardest; for example, put 4 drops of Oil of Vitriol into an ounce of Water, shake them together, and the whole will be equally acid; or take 3j of Oil of Vitriol, into which drop 4 drops of Water, shake 'em, the mixture will be equally acid; mix half an ounce of Sea Salt in an ounce of Water, part of it will subside undissolv'd; or mix brine with Water, the liquor is equally salt; the same may be said of Nitre, Sal Gem, and others; therefore that salts may be thoroughly dissolved there's a certain proportion of Water requir'd, and this holds true in solution of all salts, even in Oil of Vitriol reduc'd to a dry salt.

Put to 3 ounces of distill'd Water 9 drams of Sea Salt, if they are shaken, they are soon dissolv'd, if not, slowly; I dissolve this salt in cold Water, and another parcel in warm Water, that in the cold dissolves slowly, but that in the warm Water quickly, and in the boiling soonest of all;

all; fet them by, as soon as the boiling Water grows cold the salt settles; hence Water in summer dissolves more salt than in winter, in a warm climate sooner than a cold one, in the torrid Zone sooner than the cold one; as therefore putrefactions are proportionable to the heat, they are greater in warm than in cold countries; hence boiling Water dissolves most, and ice has the least of salt in it, all which shows that heat enlarges the pores of the Water, and cold contracts 'em; hence it appears, that this solution depends upon salt Water, and heat; wherefore, unless we know the proportion of heat, we know not the quantity to be dissolv'd; and it is certain that Water without heat does not dissolve salt; 'tis observable that ice mixed with salt will thaw; hence the salt has a power of heating and expelling of cold; I could add more, but I leave it to your speculation. Whilst the Air was of 38° , I took two ounces of the powder of Sea Salt and dissolved it in 6 ounces and 3 drams of distill'd Rain-Water; but Sal Gem required 100 and 11 ounces, and 11 drams to dissolve an ounce; Sal Armon. required a 100 and 11 ounces and two drams; 9 drams of Nitre were dissolv'd in 6 ounces; Borax requires 20 ounces of Water to one of the salt; one ounce of Alum requires 14 ounces of Water; one ounce of *Epsom* Salt is dissolv'd in ten drams of Water; one ounce of Salt of Tartar in an ounce and half of Water; 3 ounces of Water dissolves half an ounce of Arcanum duplicatum; three ounces of Water by concussion dissolves a dram and half of Copperas; hence some require more Water than others; those which run in the Air are soonest dissolved in Water, and they part with their Water latest on the Fire, as is seen in Salt of Tartar and Oil of Vitrⁱol;

triol ; but when 111 ounces, and 11 drams of Water have dissolv'd an ounce of Sea Salt, and it will hold no more, take half a dram of Nitre, and 'twill be dissolv'd, then take any other salt, 'twill dissolve it ; vitriolick salts depofite one ounce in Water, and by cristallization and repeated folution, is all turn'd into Ochre : (l) The eafier Water diffolves falts, it retains them the fafteft ; there are fome things particular about the folution of metals in Water ; fome falts diffolve metals, and they are diffolv'd in Water, which folution happens more perfectly, the more falt is requir'd ; and then this falt mixes the metal equally with the Water, otherwife a precipitation happens, which is call'd Magiftery's, Salts, Vitriols, Sugars, Cryftals, &c. The metal is the diffolvent, and the Water muft be in certain proportions ; if the Water is entirely taken away they lofe their transparency ; hence have we potable metals, which act by their acid and the proper virtue of the metal united (m).

Water does not diffolve all metallick falts, for example, it does not diffolve Butter of Antimony, which is precipitated by it into a white powder ; it diffolves Alcohol, but by concuffion only, otherwife it will immerge ; alfo it will diffolve fermented oils, and brandy will mix fooner than Alcohol ; but if Water be impregnated with falts, fuch for example, as Oil of Tartar, neither concuffion will make 'em mix, but the Alcohol mounts to the top, or depofites the falt, where 'tis eafily feparable from the Water ; as appears in Water impregnated with

(l) No, for 'tis all Ochre except the falt which the Water has diffolv'd, for we don't fuppose Water diffolves Earth.

(m) This author in his proceffes denies this affertion ; he often denies any Acid or Alkali to pre-exift, even in bodies from whence they are acquir'd without Fire ; and yet he forgets this, wherever it ferves another turn. Is this an argument of ftadinefs of principles ?

Epsom salts, by pouring in the Alcohol, the salt precipitates, as also appears in the *Offa Helmontiana*; Water dissolves Alcohol, but not the oils that swim in it; hence rectify'd Spirits of wine, in which Oil of Cinnamon, Camphire, or Urines have been dissolv'd, grow white and precipitate; it dissolves soaps and saponaceous bodies, all soap is oil and fixt salt join'd together; it also dissolves oils highly attenuated, or essential oils; it also dissolves Air to a certain proportion, as has been said before; it also can dissolve many terrestrial bodies, particularly when they have been united to some acid salts, such as coral, pearls, &c. However, when 'tis pure there are many Earths it can't dissolve; as for its dissolving iron into rust, and brass into verdigreese, and as to what *Langelot* and *Homborg* affirm of its dissolving metals and gold, these proceed from other causes, but for earths void of all salts, such as glass, crystals, &c. it does not touch them, Water easily penetrates into bodies and their smallest pores by its slippery particles; hence does it dissolve bodies; wherefore it must encrease the weight of such bodies, and therefore merchants sell their wares to advantage in moist weather; it also increases the bulk of bodies, as may be seen in the *Acad. del Cimento. Exp. 184.* where the Cone AB, the Cone CD, after CD, was moisten'd with Air (n).

Water unites almost inseparably with salts, for decrepitate salt, and distil it, you receive a Spirit, which put upon chalk, and gently evaporate, according to *Homborg*, and you get Water, the same may be said of other salts. Sulphur itself contains Water in it, whether that Water

(n) N. B. There is no such experiment in the *Academ. del Cimento*, so that Mr. Professor has taken this upon credit.

proceeds from the Air, can't easily be determin'd; Water also is found in earthy bodies, 'tis the glue that connects them, *Paris* plaister is lime of Alabaſter, moiſten it with Water it preſently becomes a paſte and dries into a ſtone, ſo potter's clay, or bones, or ſand and lime prove cements by Water; ſtarch alſo and glues of animals grow tenacious by being mix'd with Water; the ſolid parts of animals, ſuch as horn, bones, nails and hairs, are found by diſtillation to contain Water in them, and performs the office of a glue to them; nay, chymical oils themſelves as *du Hamel* obſerves, are moſtly reſolv'd into Water, even Spirit of Wine the moſt rectify'd by Salt of Tartar, or by burning, ſhews it contains Water; however Water is not the principle out of which all things are made, ſome have ſuppoſed that cryſtal was nothing but ice which has been frozen for many ages. See *Paracelſus*, and *Acad. del Cimento*. for it has been prov'd that Water 40° colder than ever it was obſerv'd to be by nature, did immediately thaw again; it may be neceſſary for nutrition, as *Verulam* ſays, but not for the production of metals; Water alone does not afford all the neceſſary nourishment to bodies; it helps the growth of plants, and is the vehicle of other particles, particularly the ſlimy ones, according to Dr. *Woodward* on vegetation, but not the ſole nutriment.

Water refuses to be join'd with bodies, particularly with oils and oily bodies, which the leſs elemental they are, the more it repels them. Some ſolid bodies alſo reſuſe to join with Water, as the hairs of animals, and feathers of fowls, and ſome other things; however if we boil Water with fix'd ſalts, it does not then repel oils; poliſh'd bodies are found to repel Water; hence

hence the scales of fishes hinder them from being wet.

Let us now take a view of the different species of Waters ; and 1st, of Rain-Water, this is properly the lye of the Atmosphere in which all bodies are found, as I've observ'd before, namely, Spirits, Salts, Oils, &c. the seasons of the year diversify the rain ; the vernal rain is the fittest for growth, rain after drought is the more compounded, also rains after winds brings various particles from foreign parts ; rain after hot weather is aptest to smell (o) ; whether rain Water when kept is apt to grow sour, I can't affirm ; but when it smells, it may again be made drinkable by boiling, adding a little acid, which wou'd be of great use to sailors to know. I never could yet find by any experiments that Water wou'd ferment, and that brandy cou'd be had from it : I have learnt by experiments that the sea weed will grow in rain Water upon the tops of mountains, which I discover'd by the microscope when they were very young, the seeds of plants, are brought down by the Air and fall upon the Earth, even the eggs of animals are carried up, and thrown into the Water and are hatch'd there ; Rain-Water kept degenerates at last into a slimy body, and deposites a sediment, and smells and tastes badly ; however 'tis reputed the lightest being distill'd by nature, and Chymists have no finer than it is ; yet I have found that Rain-Water distill'd was of equal weight with common Water : Snow-Water is said to be the lightest, and the cleanest is the best ; hence snow found at a distance from

(o) Yes, indeed ; but it had been enough to have acquiesced, in saying that rain contain'd all sorts of corpuscles, and that heat is the aptest weather to produce putrefaction, as he had said before, therefore rain in hot weather is apt to smell. Repetition is a tedious task to hearers.

any habitable place is the most pure, it keeps the longest from smelling; *Rudbeck* shews that it leaves a crust upon the earth, which makes it fruitful; this Water digested smells, and affords oleous spirits, and a fragrant spirit which dissolves Gold; *Act. Lipsiens. Anno 90. p. 26.* if kept in hogsheds it putrefies and grows clear again; that Rain Water is the most impure that falls in hot weather, and in cities, where smoke infests the air; and I have found that after thunder it had a froth somewhat nitrous, and if Rain falls in stormy weather upon cloaths, they will abound with worms; *Phil. Trans. N^o. 127. p. 622.* from hence may be understood why Rain nourishes the ground: If we distil Rain Water with lixivial salts, or any others, they will impregnate it with their taste; 'tis purest when boil'd: If you mix this Water distill'd with common Water, the mixture grows white; this Water dissolves soap the best, it also whitens linen and wax the best, it grows warm and cools soonest; if you pour melted Gold or Silver into it, they granulate, which is useful for metal-workers to know; other metals melted on the fire, or water thrown upon them, fly off with great violence; and if Water falls upon copper whilst 'tis melting, it indangers all around.

Fountain Water is produc'd from Rain that falls into subterraneous passages, from whence it issues: These fountains are most frequent where there are mountains, for when these places are higher than where the Water flows out, then there the spring flows out so much the higher, as the place where the Water collected is higher than the mouth of the spring. (p) Fountain Water is not purer than Rain

(p) This honest Gentleman is bewilder'd in this very easy air, for as *Marriotte, p. m. 14. Ed. Eng.* explains it, the rains fall, pierce the Earth, and are retain'd till they make

TOM. I. L a pas-

Rain Water ; however, when it passes through flint or sand, it is strain'd from all heterogeneous parts, because the small particles are united into such pores as hinder the passage of those parts ; however, if it runs through matter that can be dissolv'd, it becomes impure, and partakes of the nature of the glebe ; hence so many Spaws, differing according to the nature of the soil ; hence petrifying Waters, which being drank do not breed the stone ; *vid. Reg. Act. Sci.* 91, 92. All Fountain Water boil'd deposits a sediment ; 'tis very singular that in wells dug 2600 feet deep, no Water should be found : See *Plott's Desc. of Staffordshire*.

The matter of Rivers and Fountains is the same, what therefore is said of Fountain Waters may be said of the other ; the chief difference is, that Fountains flow from under ground, Rivers are expos'd to the air, and consequently receive all that the winds or atmosphere can afford : They come from mountains and run into the sea, and consequently change their corpuscles as the parts they run by ; therefore we cannot easily pronounce upon their nature, to which difficulty rains, and the several creatures that swim in them, contribute : Hence does it stink under the tropics ; hence does it smell and grow sweet again ; hence, when they smell, if the hoghead is clos'd, that smell abates in five hours ; when Sea Water is distill'd and mix'd with River Water, it hinders its putrefaction, says *Du Hamel*. In the kingdom of *Congo* there is a river which affords a tenacious matter, that hardens like iron at the fire : *Act. Lips.* 1687. p. 65c. and 1683. p. 519. The same transactions tell us, that the *Roan* water does not smell. Rain Water, Snow Water, Foun-

a passage and run forth ; and if Rains are scarce, or it don't rain for many months, these springs fail.

tain and River Water, weigh nearly the same hydrostatically; so does the Water of the River *Ganges*: 'Tis hardly credible that Water in the bulk of one pound should be four ounces lighter, and I wish Mr. *Boyle* had tried this oftner; were it so, *Herodotus* may say true of the long-liv'd *Æthiopians*. Let this suffice on this subject; only it may be observ'd, that the contents in the Water are the occasion of putrefactions.

We shall now speak of standing Waters: If we consider those ditches about *Leyden*, we find them to be a lixivium of all the filth in town, to consist of alum, tartar, and all other sorts of things, and which unloads itself into *Harlem-mere*; hence do we dye better in this town than elsewhere; the Water is more ponderous and exhal'd, affords insects, besides terrestrial matter which effervesce'd with *aqua fortis*. Rain Water is the lightest, River the next; from *Salan-Hall*, Water was two lines heavier, a Fountain Water there four lines heavier, another Water there six lines heavier, and another that had stagnated was six lines and a half, and the ditch Water was seven lines heavier; all which experiments *Hoffman* tried: From whence 'tis necessary to make use of trials to distinguish the purity of Water, which is done by silver dissolv'd in spirit of nitre, or oil of tartar or *deliquium*, or *Sacch. Saturni*; if the Water do not grow white from these 'tis pure. (q)

The natural state of water is ice, which is fluid only because fire is in it, this glassy part melts with the least heat; I have already taken notice that ice wou'd never make crystal, we can't heat above 214° ; as soon as it is dissolv'd in 33° of water, it produces all its physical operation; 'tis

(q) N.B. The professor mentions this very often afterwards.

the only vehicle of our nourishment, and which we cannot want; it is the most fluid and penetrating of any, without it our blood can't circulate; hence our life depends upon a sufficient quantity of water; it makes us grow, and all the functions of life are owing to it, death often is owing to too much, but oftner to too little; as in animals, so in vegetables it is of use, but for their growth, as *Woodward* and *Hale* have prov'd, without snows or rain there wou'd be no fructification; 'tis also of great use for the growth of metals, it dilutes them, and keeps them in the form of a Juice, it dilutes, changes, encreases and mixes 'em one with the other; hence appears the wonderful use of Water, colours cannot be seen without it, smells are brought to perfection by it, tastes depend upon it by its dissolving mixtures, aliments, medicines, poisons, solidity, depend all upon Water, so do effervescences, so does fermentation, so does putrefaction; it parts salts from earth or oils, it helps precipitation and sublimation, we can direct the degrees of heat by it, from 33 to 212. Water indeed, is better than oil for this purpose, because oil grows thick by the fire; from hence we can keep the fire as equal as we please; the steam and exhalations of water are very active, for its steam will putrefy bodies; (r) 'tis from hence arise plagues and pestilential diseases, 'tis from hence that woody places are so unwholesome. Ice is lighter than Water, and swims upon it; the reason of which is, that the same matter takes up more space, and so weighs less, the cause of which is the Air contained; hence it is, that Water freezing, cracks even golden vessels, as you may see in the *Adel Cimento*.

(r) N. B. To wit, it dissolves the Salts and makes them

Ice made of water, from which the Air is exhausted, is the heaviest, and will even sink under Water; *Sagg. Exp.* 171. Ice will melt with sea-salt, sal gem, fountain salt, salt armoniac; but then it encreases the cold, and this coldness may be encreas'd to any degree; spirit of *French* wine, of sea-salt, of nitre, *aqua fortis* and *aqua regia*, mix'd with powder'd ice, do greatly augment the cold, as has been said before on *Fabrenheit's* Thermometer; the strongest ice wou'd be got by exhausting the Air and pouring after *Fabrenheit's* manner, these strong spirits upon ice, but this ice is again dissolv'd by the fire, nor will it change into crystal; 'tis observ'd that Water kept in a vessel of glass hermetically seal'd for an age, will not putrefy, tho' in the air of *Rome*; *Boyle* and *Du Hamel*. Water contains somewhat subtiller than Air, for when exhausted in the Air-pump and shaken, it afforded sparkles like fire; *Du Hamel*, p. 395; tho' it abounds in the Air, yet the naked eye do not discover it, wherefore is it necessary to make use of hygrosopes, such as oil of sulphur, or oil of tartar, and such like, to detect it.

The waves move in eight seconds twelve feet and a half in diameter, whilst sound runs 680, so that a wave is to sound as 765 to one, which comes near to the proportion of the weight of Water to that of Air, they are circular, and nothing of an obstacle changes this proportion.

I very much doubt of Mr. *Boyle's* experiment, that informs us, that after distilling water 200 times, an ounce afforded six drams of earth, for the dust in the Air gets in and deceives us, and tho' I have try'd the experiment and have found a white earth, yet not in such a quantity, and I doubt Mr. *Boyle* was deceiv'd by the person he confided in.

Of EARTH.

Philosophers and Chymists have made use of the word Earth to signify one of their elements, out of which all things were made, we mean by it a fossil, simple, hard, crumbling body, fix'd and not flowing in the fire, nor to be dissolv'd in water, alcohol, oil, or air; 'tis a body that has the triple dimension and enjoys the properties of other bodies; I look upon it to be a fossil, and mix'd with every thing we dig up, and hard to be separated from them, its weight is greater than that of vegetables, oils, &c. Pure Earth has no mixture of the other elements, nothing is more simple than it is, 'tis hard to a degree and easily crumbled or powder'd, and it will not flow in the fire, but remains unchangeable; Rain Water distill'd, gives out an Earth, which freed from all Salts, is call'd Virgin Earth; the Air abounds in this Earth, as I have hinted above in the history of the air, and by exposing black silk will be soon perceived; this powder is mostly Earth, and unites itself to all bodies, nor does the fixedness of Earth hinder us from knowing that it may be suspended in the Air; sand is a fixt body, yet it has been known to be lifted up, and destroy'd armies in *Egypt* and *Libya*; gold is a fixt body, yet the least breath will blow up leaves of gold into the Air, and tho' 'tis very fixt, if you mix it with *regulus* of antimony and merc. sublim, 'twill all fly off; wood flies into soot, and yet the Earth of that soot is a fixt body that will bear the fire; thus you learn that a body which is fixt can be lifted up in the Air.

Vegetables by burning are turn'd into ashes which will fly up in the air with the least Earth; all plants afford this Earth; wash this Earth with
Water

Water, you gain all the salt, and the Earth subsides; the longer you wash this Earth the purer it is, and this is the pure chymical Earth, without taste or smell, white, soft and not sonorous, indissolvable in any fluid, fixt in the fire, hard to turn into glass, which by Water may be form'd into a vessel that will bear the fire; and for Cupels, in these Gold or Silver are gotten pure by a mixture of Lead; it holds Lead and does not vitrify; this is the Earth out of which *Vulcan's* mystical fan is made, thro' whose holes all bodies run, save Gold and Silver; this is that sieve for all metals melted with Lead.

The same sort of Earth is got from the foot of vegetables, which if put into an iron frying-pan and bak'd, turns into white ashes, which being wash'd in Water leave a pure Earth, as before. Hence we see, that Earth may be made volatile, and fly up into the air; distill foot, and besides what other particles it affords, there is a black Earth at bottom, which being wash'd pure, leaves the Earth at bottom: Which shews that the Earth is fixt when 'tis freed from its volatile parts; how full therefore is the Air of this terrestrial matter, where vegetables are burnt.

When we distill vegetables, we divide 'em into two parts, one mounts, the other stays behind at bottom, the volatile part is Water, spirit, salts and oil; if they are burnt in an open fire, many thicker parts are lifted up, and therefore less Earth is left behind; whereas in distillation, the most volatile rise only; when you have done distilling, a black coal is left behind, which you can never render volatile, put it in an open fire, 'twill flame and grow white Earth; wash this, and you have the Virgin Earth; distill the Oil over again, and you have it more penetrating and pure, and equal to an Alcohol, if it be often

L 4

rectified;

rectified; yet after every distillation some Earth is left in the retort. Hence we see, that Earth ascends with the volatile parts, but more particularly with the Oil, and 'tis this which makes the Oil so thick, and which being parted from the Oil, the Oil thereby becomes more pure and volatile.

Let us now consider that fixt Salt which we got from this Earth; who would have thought there was Earth in this fixt Salt since it dissolv'd in Water? take this lixivium and filter it, no terrestrial matter appears, even by microscopes, in it; and if kept for years, nothing will subside; inspissate this lixivium, reduce it by fire into a Salt, commit it to a strong fire till it flows, pour it into a warm mortar, beat it to powder, expose it to the air till it runs, and you will find the same Earth as you found in the ashes. (f) Let this Salt run again *per deliquium*, and still the same will appear, and this will happen at every solution and calcination: Weigh all these Earths, and you will find they weigh less than the Salt did, which shews that some part of the Salt is made volatile; hence may it be concluded this Earth was in the Salt, and was dissolv'd in the water, unless you suppose a transmutation of the Salt in the Earth; chymistry has always known that Earths united to Salts will dissolve in Water. Earth joins with an alkaline Salt into Glass, which may again be resolv'd into its principles; Earths by Salts may be so order'd as to dissolve in Water, as chalk with acids, &c. Hence, 1st, These alkaline Salts are Earth in a large pro-

(f) N. B. Our author has already forgot what he said on the powders that float in the Air; is not this Earth part of that powder? Or as he reproves Mr. Boyle on Waters turning into Earth, that it proceeded from the Air.

portion;

portion; *2dly*, The Earth is hid in these Salts, so as to be dissolv'd in Water; *3dly*, Nothing can attenuate this Earth so much as the fire, which causes it to unite to these Salts; wood burnt to a coal, shut up in an iron box, and committed to a great fire for many hours, remains a coal without any signs of an alkaline Salt, but in an open fire it affords Salt; for wash this coal you get no Salt, but wash the white ashes and you presently gain it; *4thly*, Therefore alkaline Salts are compound bodies; *5thly*, The open burning consumes the oil, which hinder'd the Salt from dissolving in the Water. This Salt kept long in the fire becomes volatile at last, which, however, mix'd with a certain portion of Earth, turns into Glass. *6thly*, No Salt is fixt of itself, but as it has Earth join'd to it, which by drying and often correcting becomes volatile. *7thly*, These fixt Salts are divided into a volatile Salt and a fixt Earth; *8thly*, Hence these Salts are Salt and Earth, with a little Water join'd to it; *9thly*, This Earth resides, and is got out from Water, Spirits, Salts and Oils; and if these bodies are rid of their Earth, they fly into the Air, and become invisible, the Earth remaining behind; wherefore fixity is to be attributed to this Earth.

Let us now enquire into the Earth of Animals: All Animals do putrefy, and all their parts fly off, leaving nothing but Earth behind, as appears in their Carcases.

The humours of human body being committed to the fire, by a heat of 212° afford Water, which does not differ from the Water of Vegetables, only smells of the Animal; by encreasing the fire you gain the Spirit which smells and effervesces with acids, which collected apart and re-distill'd, affords Earth; encrease the fire and you will get Oil, and these re-distill'd afford Earth, and the
thicker

thicker they are the more Earth they afford ; in this Oil is contain'd a good deal of volatile Salt, which becomes pure by rectification, but always after sublimation there is a vapid Water at the bottom, nor can we easily separate this Water from the volatile Salt ; after the first Oils, a thick tenacious Oil follows, resembling Pitch, which being re-distill'd affords a great deal of Earth, and the Oil becomes pellucid, as I have tried in Oil of Hartshorn ; so that Earth is the occasion of the viscosity of Oils, and hinders 'em from being volatile ; at last comes forth the phosphorus, which expos'd to the Air falls into flames : 'Tis a question what this phosphorus is, whether it be an animal or vegetable substance, or whether it be not the true offspring of fire ; it burns quite away, and remains like wax at the bottom of Water ; 'tis rather an oleous than saline substance, and has little Earth in it ; the Earth of animals and vegetables has a near affinity to each other, and there is also a near resemblance of the parts of the liquors ; the salts in animals are mostly volatile, neither do I find fixt nor acid salts in animals, (t) whereas in vegetables there are a great many acid salts, tho' there are also volatile salts in them.

Putrefaction separates the Earth from bodies ; for when bodies of any kind are putrefied, you gain a volatile but not a fixt salt from them ; 'tis observable that putrefy'd bodies promote fertility : One would suppose, that because putrefaction separates the Earth from bodies and other elements, that fermentation wou'd do the same ; but it never separates the Earth from Salt and Oil, it promotes acidity and leaves the fixt Salts, it changes the Oil into an Alcohol, but not the whole Oil ; we find then that Earth is always the same

(t) N. B. But our Author finds an armoniacal or mix'd Salt, which contains an alkaline, a fixt Salt, and an Acid.

in all bodies, and Cupels can be made as well from the ashes of vegetables as animals, it gives strength and firmness to bodies; and hinders the others from flying off, and it resists the Air, Water and Heat; in burning bodies till their whole consumption nothing remains but the Earth.

Let us now take a view of the Earth of fossils. First, We find the native Salts, such as Nitre, &c. dissolve these in pure Water, digest 'em, and an Earth will subside, and the Salt will crystallise each in its proper figure; the remaining liquor being thicken'd till a crust appears at top, will give crystals, but less pure; proceed with the remaining liquor, there remains water, which is not easily dry'd, but is fatty, saline and earthy; which being dried at the fire, runs and is sharp and acerb; and in all these operations Earth is afforded; and by repeated crystallisation and solution, the whole Salt flies off and leaves the Earth behind.

Let us distill these fossils, by mixing them with Bole or Earth; they are divided into an acid spirit, and Earth at the bottom; wash this Earth, and you gain a fixt Salt; redistill this acid spirit, and Earth remains behind; when we have rid these spirits of their Earth, they smoak and fly into the Air, as appears in *aqua fortis*, spirit of Nitre, and *Glauber's* spirit of Salt; hence both alkaline and acid spirits appear to be volatile, and are only fixt by Earth; mean while two things are to be observ'd, whilst the acid of Vitriol and burnt Brimstone is fixt in 56° of Fire, but by reiterated distillation becomes fluid and deposits Earth: This indeed may depend upon somewhat terrestrial, which can't easily be separated; again the most volatile acid Salts being united to alkali's, turn armoniacal; if then Alum has its Earth taken off, it becomes volatile; Calcanthum dissolv'd in Water and digested, affords Ochre, and by repeating

peating solution and crystallisation most part of it is turn'd into a yellow calx, another part into an austere fat liquor, and the remainder vanishes in the Air, the calx may be remelted into brass or iron, according to the nature of the Vitriol; Earth itself concurs to compound Metals; I never got true Earth from Metals, for what can be vitrify'd is not Earth, but Metal.

Let us now examine sulphureous bodies: Such as Bitumens, Naphtha, and the like, which if burnt, afford Earth, as animal or vegetables did; Brimstone always affords something of Earth at first distillation, and tho' its flowers be resublim'd, afford little Earth, yet when mix'd with fixt Salt upon the Fire, and expos'd, a great deal of Earth settles: The Oil which is united to the acid, gives a great deal of Earth, and by the Fire it revivifies.

The ancients thought Metals were made of Quicksilver, and some other principle to make 'em ductile, but the moderns relying upon experiments, from analysis and composition speak of a vitrifying Earth as the basis of them; but I have never discover'd such an Earth. Quicksilver taken from the mines and put into a piece of leather and press'd, leaves Earth behind, if distill'd, it leaves fœces behind, which I dare not pronounce to be Earth; shut this Quicksilver up in a strong glass bottle, cork it well, tye it down with a bladder, and fasten it to one of the wings of a wind-mill, so that it may be thoroughly agitated, and it will turn into a black powder, which is true Earth, as some suppose; but as this can be reduc'd into Quicksilver again, 'tis the same body in a different shape, 'tis said to be good in ulcers, in an ill habit, and it is *Homberg's* experiment; neither are metals Earth, for they do always recover their former shape, or can be vitrify'd;

Iron

Iron indeed affords somewhat resembling Earth; Gold, Silver, Copper, Tin, and Lead prepar'd after a simple manner, and amalgamated with Quicksilver, and afterwards beaten together, do afford a black powder, which leaves after washing in Water a metallick substance; this being beaten again, affords the same powder; and this labour often repeated, which some would bring as a fair argument to shew that Metals were Earth, but I don't think this is Earth, only a metallick product, whose properties are admirable; if you seek for Earth in this powder, you'll be deceiv'd, but you'll find many things you did not expect; for Gold, Silver, and Quicksilver are still reducible by the fire; I can testify for Gold, that I've reduc'd it by acids into a liquor, have made it into a soft paste, and made it a calx several ways, it can be turn'd into an Oil, be chang'd into the form of butter, turn'd into glass and resemble Earth; yet still it was reduc'd into Gold again; and distilling Gold with Quicksilver, yet still it return'd.

Now let us draw the following Inferences; *1st*, 'Tis the basis of all firmness, and gives solidity to bodies, and hinders things from flying off, and makes the structure. *2^{dly}*, So that there is a great agreement among all the kingdoms, by each of 'em having this principle in them, since most bodies are found to have it. *3^{dly}*, Bodies therefore having the same principle in them the changes are easily made. *4^{thly}*, Iron having some Earth in it, is more safely given internally. *5^{thly}*, Bodies that have Quicksilver for their basis, are not so readily to be given internally, being too heavy for the body. *6^{thly}*, If neither Earth nor Quicksilver were in nature, could not every thing then turn to Atoms and fly into Air? *7^{thly}*, Earths are fit for chymical Instruments. *8^{thly}*, Salt wou'd fly off
were

were it not for Earth, for example, if Salt of Tartar flow alone in the Fire, and unless it pass thro' the pores, it remains long fixt, but if you mix it with three parts of Tabacco-pipe clay, it becomes all volatile; so Nitre by Earth becomes volatile. *9thly*, Earth serves to purify volatile Salts from their Oils. *10thly*, It hinders the expansions of viscous bodies, so that honey, blood, urine, and other bodies being mixt with Earth, will distill without swelling or breaking the vessels. *11thly*, Sand is not Earth, but small crystals can be united into glass; neither are boles nor *Terra sigillata* Earths, but compounded bodies, which some have call'd the fat of the Earth; in them abound Alum, Salts, Calcanthum and the rest, as has been discover'd; hence are they a Chaos of all elements. I cease to speak any more of Earth, having tir'd my readers with my great prolixity: However I thought these things necessary to be mention'd; I've given you a faithful description of the elements; I've told you what the Alchymists have said of 'em, at length I speak it without boasting or envy; I believe I may say, I've told you some things that were never heard of; you've seen that those things are very compounded, which are taken for the elements, which when pure are really such; to what does Fire, Air, Water, Earth yield to in simplicity, and consider'd in another light, what is more compounded; I've endeavour'd to say what is true and sound, if I have doubted, I've admonish'd you of it; what I've interspers'd of Metals, I had a mind some time ago to have conceal'd, but your presence and diligence invited me to speak it.

On M E N S T R U A.

Along, my pretty Hearers, let us chearfully pass on to another head; for as we have said enough and too much of the elements, let us now say as much of what *properly* belongs to Chymistry, and which is the chief part in it, and in which they justly triumph.

By a *Menstruum* is understood, that one body dissolves another, so as to be blended like one thing: Not when the dissolvent and dissolv'd recede from each other.

The name is from *Mensis* a Month, because the dissolvent and the body were kept in heat for a philosophical month (40 days.)

The nature of a *Menstruum* is to dissolve and be dissolv'd; the body that dissolves is intimately blended with the body dissolv'd, and there is a division of the dissolv'd into very minute parts; hence there is a difference between this division and the mechanical one, of a Knife, &c. and the Bread it cuts, &c. for these instruments are not divided, tho' what they cut, is; but now, when I think better of it, it seems to be the same thing; for the dissolvents, like Knives, &c. have their size, figure, hardness and weight, by which they cut, divide, and are contiguous to the body so divided, and seem to be united into one thing.

Menstrua are divided into fluid and solid, tho' so long as they are dry or solid, they can't be call'd properly *Menstrua*, however we retain the division.

To the solid *Menstrua* we refer all the Metals but Quicksilver; whilst they continue solid, they don't act, but if they are melted, they mix with one another; join 1 oz. of Gold with 10 oz. of Silver, this is 11 oz. give 1 gr. of this to a Goldsmith,

smith, and he will draw $\frac{1}{17}$ of a grain of Gold from the mass. Gold may be divided infinitely; if then I mix 100000 ounces with one grain of Gold, you could still get the hundred thousandth part of Gold from it, which is somewhat wonderful: Perhaps this was the reason why the Chymists heretofore suppos'd that Metals were only open'd by Metals. 2dly, Half Metals, such as Antimony, Cinnabar, Bismuth, Marcasite, and Zink, are referr'd hither, for they can be fus'd and mix'd with Metals, and by their mixture make 'em brittle; Cinnabar is the most difficult to mix. 3dly, Hither are referr'd all dry Salts, such as Alum, Borax, Nitre, Salt Armoniac, *Sal Gem.* Sea Salt, Fountain Salt, Vitriols, fixt Salts and sublimate; for these mix with one another, and with Metals. 4thly, Hither are referr'd all Sulphurs, as Brimstones, Arsenicks, and Cobolt, which mix with one another and Metals. 5thly, To this class are referr'd Cements, which exalt the colour of Metals.

Some of these *Menstrua* unite with the body, and appear to be but one thing, as Lead with Tin appear to be but Water mixt with Water, and seem to the eye as homogeneous; and the same may be said of Metals and Semimetals blended together, for mix a pound of Tin and $\frac{3}{4}$ of Regulus of Antimony, melt 'em upon the Fire, the mass is so brittle as not to be malleable, yet appears to be a mass all alike; so fixt Salt joins with Sand into glass, so Mercury with Sulphur into a black powder, which by being sublim'd, is Cinnabar; thus Vinegar pour'd upon shell powders, &c. unite into one hard mass, and in all these cases the dissolvent and the body to be dissolv'd, do concrete into one mass, which is every where alike to itself.

So much for dry *Menstrua*; Let us now proceed to the moist ones, such are Vinegars, Water, spirituous Liquors, acid and alkaline Spirits, fixt Salts *per deliquium*, &c. Some of these *Menstrua* before they begin to dissolve, are fluid, and continue so, this appears in the solution of Metals by Mercury, they make an amalgam or paste, which you may dilute with the Mercury at pleasure; which whosoever could make hard would be rich; so acids which dissolve Metals remain fluid, nor can they easily be dried; on this we need insist no further.

If we consider the action of these *Menstrua*, we shall find that in the time of solution, the body to be dissolv'd is made to enter between the particles of the dissolvent, and thus one compound is made, differing much from the nature of the simple body: 'tis therefore plain that this association or union depends upon the application of the dissolvent to the body to be dissolv'd, and that the particles of the dissolvent recede from each other, and are attracted to the matter, to be dissolv'd, or *vice versa*: Therefore this force is reciprocal, for in the solution of Gold in *Aqua Regia*, where the Gold is 18 times heavier than the *Aqua Regia*; were it not some such power, the Gold would lie at bottom, and the *Aqua Regia* at top; these mechanical actions therefore rather proceed from friendship than enmity, by which the parts are united; the struggles rais'd upon their mixture end in peace as soon as the parts are united; behold this diluted spirit of Nitre, 'tis at rest; behold I put this piece of Iron into it, behold what an expansion, heat, noise and smoak is rais'd; but behold this struggle lasts no longer than all the parts of the acid are join'd to all the parts of the Iron; behold also this struggle is not instantaneous but successive, and the reason is, because the surfaces

T O M. I. M faces

faces are touch'd and attack'd successively: wherefore the struggle encreases every moment till the whole is over; the Fire assists this solution, what wou'd become of all things if the Fire were absent, can hardly be defin'd, 'tis impossible quite to banish it, and solutions are slowly made in extreme cold.

However some require a large Fire for this purpose, as when Mercury dissolves Metals; some a gentle Fire, as when Salts are dissolv'd in Water; others a moderate Fire, as when an Egg is to be diluted in Water.

The Fire by its rarefying, dividing and moving power, makes the attraction the quicker and stronger, as may be observ'd in Salt Armoniac, dissolv'd in cold and warm Water (r): Therefore *Mensstrua* introduce no change, but an union betwixt the parts, for let Metals be dissolv'd in any acid spirits, you can recover 'em, and return them to their pristine shapes; hence their essence is not chang'd, their particles are only divided; the same happens constantly, I have above fifty times dissolv'd Gold and Silver with Mercury, and have as often call'd off the Mercury, and left the Metals pure; thus Water can be call'd off the Salts; thus Oils from Salts; thus Glass may be return'd into Sand and Salt, thus Sulphurs from Salts, or from Metals; thus Resins from Alcohol; but you will object that by *Mensstrua* new bodies are made, as appear in *Sacch. Saturni*, where the Vinegar having prey'd upon the Lead, by distilling you get a brandy Spirit, which is true, but their connexion is too strict for all their parts to come off; examples of this kind are common, thus a Lancet will cut, but sheath'd will do no harm; as then the easier this Lancet can be unsheath'd, you may

(r) N.B. Why then are Crystals never made by Heat? The rule is variable.

the easier perceive what it is, whereas if it stuck very close and were connected inseparably, then all wou'd affirm that this Lancet was chang'd; a Cylinder of Silver gilded and put into *aqua fortis*, the whole Silver contain'd within that golden sheath will be dissolv'd, the sheath remaining; therefore if the acid be united to the Lead very strictly, it will not mount, however the Lead is not turn'd into this inflammable spirit, and therefore there is no change but an union (s). So that where *Menstrua* are not separated from the bodies, 'tis an argument of a strong connexion, and when they are, and the bodies seem to have chang'd their shape, this change is only in the figure not in the essence. From what I have said, it appears that these *Menstrua* act by motion, for without this the parts would remain in the same position.

But altho' 'tis very true that motion is the occasion of solution, yet 'tis hard to explain the modus; for as to propulsion, gravity, elasticity, or magnetism, 'tis in vain to seek it in them, wherefore this solution depends upon the action of the Fire, for whenever any solution happens, the Fire drives these parts against each other and keeps them there; other common solutions, as of Dust in Water, Oil in Water, Stibium with Salts and Metals, the Metal subsides and the Scorix immerge, so in fixt Salts and rectified spirit of wine, and such like, it appears to me that *Men-*

(s) This whole Paragragh might have been much easier prov'd; he starts an objection which he has by no means solv'd, 'tis true that the Acid and Lead are strictly united; 'tis also true that the Acid contains somewhat of a brandy Spirit, which coheres not so strongly with the Vinegar as the Acid does with the Lead, and therefore it mounts; but pour on any alkaline Salt, then this Salt attracts the Acid more strongly than the Lead; therefore from such a mixture you acquire a neutral Salt, and the Lead will soon return to its former shape.

M 2

strua

turn to 166

hardness, figure, weight, and impulse, bodies are attenuated and divided, and then they separate, and this is the way to know a mechanical action (t).

As often then as any solution is made, these bodies are carried towards each other and remain mix'd, tho' of different gravities; hence we may say 'tis partly done by a mechanical power, and by some other secret and singular property in the dissolvent, by which they attracted each other.

Let us exemplify these assertions; suppose clay boyl'd in Water, the force of the Fire divides the Clay and mixes it with the Water, remove it from the Fire and the Clay subsides, this I call a mechanical solution; but if you take *sal gem.* and dissolve it over the Fire in Water, tho' 'tis heavier than the Water 'twill remain suspended in it, something therefore suspends this; thus Alcohol dissolves its like.

I shall divide *Menstrua* into four sorts. The first shall be on mechanical solution, the next shall be on *Menstrua* that cut by mechanical motion, and also by repulsion; the third upon mutual attraction, in the last order I shall range all those *Menstrua* that act in all these manners: This last has far the greatest share in *Menstrua*; I shall give you an example of several of 'em, first where there's a mechanical solution, granulation, where melted Silver is thrown into cold Water, and divided into small particles; in this case the Silver divides the Water,

(t) Pray what does this author suppose motion to be? Is it not a mechanical property of bodies? is it not an impulse? and altho' motion is not a constituent part of bodies, yet 'tis an affection which has its own proper laws: And these laws are mechanically and mathematically accounted for; 'tis not body but a *modus* of bodies, as an angle is not body, but a *modus* or inclination of one line towards another; and yet tho' this inclination is not body, it has its real properties, the same may be said of motion.

and

and is divided by it, yet after this each takes up its proper place; but if on the contrary you melt Copper and throw it thus into Water, there is such a repulsive force betwixt these two, that it will fly into a thousand pieces and prove dangerous to the by-standers.

The next example is, a dry and fluid body united by attrition and divided by attraction, as appears in *Æthiops Mineral* and in *Cinnabar*; you mix the Mercury with the Sulphur, and they unite; you force them up by a fire, they are still united, and they are *Cinnabar*; mix an attractive body with either of these, such as fixt Salt, Lime or Iron, the Sulphur fixes to these, and the Mercury mounts up pure.

Next I take Antimony, put it into a Crucible and melt it, it separates into two parts, into a metallic *Regulus* at the bottom and *Scoriæ* at the top, so that the fire has repell'd the *Scoriæ* from the *Regulus*, and made each attract their own Particles.

I shall shew you another example on dry *Menstruums*. I take salt of Tartar one oz. flower of Brimstone half an oz. mix them and melt them in a Crucible, they run into an Oil; I also mix Antimony and salt of Tartar and put them in a Crucible, they unite into glass. I take one oz. of Silver and three oz. of Brass, put them in a Crucible, melt them, they unite into one metal, and are hard to be separated without lead, in the Crucible; the fire therefore mixes them together intimately; in this case the metals do not divide, but are united: You see therefore the various manners of drying *Menstruums*.

You will now have a different Idea to what the ancient Chymists had of *Menstrua*, for when they saw a corrosive body corroded a harder and not a softer one, they were puzzled, not considering

strua act mechanically, when by their magnitude, their principles were not the occasion of action but the mechanical ones.

Fire is the universal dissolvent, for there is no body but will be dissolv'd by some degree of heat, the greatest melts bodies and vitrifies them.

We must take trituration into our views, this often supplies the defect of fire; so *Langelot* has said to have beaten Gold into a potable liquor, and *Homborg* has prov'd that Gold can be dissolv'd in Water, if well beaten together.

3^{dly}, Let us consider the fire and trituration together: Let Mercury and Lead be put in an iron spoon, 'twill be an amalgam, beat this in a mortar with a glass pestle, it affords a blackness, wash it this blackness goes off; let this often be tried, that blackness still returns, and the water washes it off; and the same happens if it be distill'd, but *Harpocrates* seals my lips.

4^{thly}, Besides these nam'd, attraction come in play; let the former example of an amalgam suffice, where the particles are united strictly after they expell'd each other.

5^{thly}, The body appears in another form when the attraction is dissolv'd, and generally appears in the form of a calx; hence solid *Menstrua* act as fluids, and attrition performs the same office and alone fits a body for solution.

I will now give you an experiment in which all these causes, viz. Fire, trituration, repelling, and an attracting force, as well as mechanical action concur all together in dry *Menstruums*, so that the effects of attenuation, concoction, mutation and separation follow together. Take Antimony 16 oz. Tartar 12 oz. Nitre 6 oz. powder them apart; observe, turn your eyes this way, here an iron spoon which is made very clean, into the spoon made warm I put Tartar and Nitre together

together, put them upon the fire, they sparkle and flame, and become a fixt Salt; and as Sulphur, Nitre, and Tartar being mixt and thrown into a red-hot Crucible and become an alcalious Salt: Being thus instructed, pray, in God's Name, let's now see what will become of Antimony mix'd with Nitre and Tartar; put them into a hot Crucible after they have been warm'd, they will presently detonate; thus throw in gradually more of this powder after every detonation is over, till all is thrown in; put this into a brass Cone besmear'd with candle-grease, you will find the metallick part at the bottom, shining like Silver, and the scorïæ at top: 1st, Here is trituration of the matter into powder; 2^{dly}, they are put upon the fire to mix them; 3^{dly}, the oil of Tartar and the sulphur of the Antimony join into one body by attraction; 4^{thly}, the scorïæ and regulus are repell'd from each other, therefore mechanical force, attraction, and repulsion are all join'd together. 1. The Crucible must be very large; 2. it must be red-hot before we put in the materials; 3. let the detonation be over before we put in any more; 4. let it flow like water before you take it out; 5. you must warm the Cone before you put in the material; 6. you must anoint the Cone with candle-grease, which is better than oil. If these things are not observ'd, the operation will not succeed.

These being premis'd, let us proceed further; no body is so hard but it can be divided, Jewellers can polish Diamonds into different figures, and cut 'em with a saw mechanically; soft bodies can dissolve hard ones, as Water a Stone, Leather polishes Glass, a wooden wheel by circumrotation will powder hard bodies.

Bodies that appear to us very soft are yet very hard in their component parts, so Fire, Water, Air, acid Spirits and Alcohol, are in themselves

immutable, and do penetrate the hardest bodies; and *Homborg* that most diligent searcher of nature found that acid spirit in many years was not changed. *Hamel Hist. ac. reg. sc. p. 497, 498.* Only Vinegar changes its nature: These things prove that what appears to us to be soft, by friction and application will destroy the hardest bodies; other bodies don't act so strong as Fire, because they recoil often; gravity also contributes to these effects, which the stronger 'tis, the greater will the effects be; this strong pressure or application of a soft body to a hard one, appears in *Papin's digester*; (*u*) we see then how attrition dissolves bodies; we must then next observe the conditions requisite for solution. 1st, One condition is the *fitness of the pores*, and the bodies that are to enter those pores, if those entering particles are too large, they can't enter; I shall bring you an example of this kind; I take the strongest oil of Vitriol, put filings of Iron into it, it moves gently, but add Water to this oil of Vitriol, and they effervesce and swell violently; in like manner, put filings of Silver into the strongest spirit of Nitre, they are not mov'd; put some Silver into strong spirit of Nitre, add Water to it, they are not mov'd in the cold; put Silver and Lead into the strongest spirit of Nitre, and they are not mov'd, tho' the Silver will be corroded if you add Water; put red Lead into spirit of Nitre, and they are not mov'd in the cold, nor do they effervesce; dilute this spirit of Nitre in which the mixture is with Water, neither are they mov'd;

(*u*) *N B.* This impulse is not gravity, therefore this paragraph is ill join'd: and something is infer'd which was not in the premises; his argument is this, gravity has a great effect in solutions, therefore impulse has a great effect: Elasticity gives a great impulse, but elasticity is not gravity.

add the Fire to them, and they all begin to work
1. then, Acid spirits can be diluted. 2. Concussion promotes this dilution. 3. So many watry particles can be added as the artist pleases. 4. It may be that these particles may not unite by reason of the dilution. 5. 'Tis these saline particles that enter into the pores of the bodies. 6. These acid particles were too strongly united till they become diluted.

2dly, *Figure* contributes extremely to solutions; thus 'tis, that, as Mr. Boyle has observ'd, the webs of the key are fitted to the lock; so the figures of bodies are fitted for solution; so a bell is fitted for sound, for being struck it vibrates the Air into innumerable elliptical waves from every point of the circle, and this depends upon the shape of the bell (x). If we make use of dulcify'd spirits of Vitriol, of Nitre, or of Salt, their effects will be very different to what they were before; 'tis to be observ'd if to one ounce of oil of Vitriol you put six of Alcohol dropping it gently in and shaking the glass after every drop put in, distill these gently till the mixture grows black, then change the recipient, there will distill a choaking sulphureous phlegm that raises a cough, and along with it a sweet oil of *Calcanthum*. Hoffman. *Obs. Phys. Chym.* (y)

3dly, Rigidity is another condition for solution, for by it the body dissolving, enters as so many wedges into the minute pores.

4thly, The last mechanical cause of solution is Fire; this tosses and moves bodies effectually; a

(x) It is somewhat peculiar, that this author assigns no reason for the sound of a bell but its figure.

(y) N. B. Does the spirit of Wine and oil of Vitriol, mix'd and distill'd according to Hoffman's directions, prove any thing relating to the figure of the body? No surely.

a wedge is not driven in without a hammer: Nothing, whether Figure, Gravity, Hardness, Size, or Elasticity will act without the Fire; this makes all to go forward. These, my worthy comrades, are what are drawn from the mechanics to explain the action of *Menstrua*, but these are not sufficient.

Hence mechanical properties are not the cause of *Menstrua* dissolving bodies, but *Fire* that moves, agitates and tosses all things around, is a main instrument of these solutions, as also may the Air; bodies by their gravities press upon bodies, figure does not enter, and in short nothing acts without this universal agent; we see *Hartshorn* is not dissolved so much by coction, as a steam, and fire by diluting enters and tears bodies into their minutest and component parts. They who have therefore publickly affirm'd, that I undertook to explain all chymical events mechanically, impose upon the world; none is further from this opinion than myself (z).

We shall now proceed to examine the various sorts of *Menstrua*; and first of watry *Menstrua*, Ice is a *Menstruum* that is dissolved by, and dissolves salts and spirituous bodies. Water however is properly a *Menstruum*, when it is fluid and just

(z) Pray what is *Motion*, by which Fire acts, but a mechanical affection or mode of matter? Are there not certain laws of motion, which are every day found out or better explain'd? This state or mode of matter is call'd *Impetus* or *Velocity*, and it is not a part of matter but an effect of an impression or impulse given from an external or moral agent, which impulse continues till it meets with an obstacle; hence a projection made, when there is no medium or attraction to resist, wou'd be perpetual, let it proceed from what cause we please; now tho' Fire is a natural agent, that has receiv'd its impulse from the Almighty Hand, this does not hinder us from finding out its properties, nor from calling its properties mechanical.

freed

freed from freezing, viz. at 32° ; from that degree a hoary frost begins, and *Romer* 1709, observ'd the winter cold to have settled the glass, which he was inventor of, to 1° so that it settled 32° below Frost at *Dantzick*, which is 40° Lat. and doubtless near the Pole it was colder (a).

Water is a *Menstruum* from 32° of heat to 212° , when it boils; then it can be no hotter, unless the compression of the Air be greater or it be nearer the centre.

It is the happiness of this age, that I can't enough congratulate, that they have found out, that Water in each degree of Heat from 33° to 212° , when it boiles, dissolves more salt every degree, till it refuses any more; and as it cools, in each degree it drops parcels of salt till it freezes and drops all its salt; which however, when it thaws and heats it resorbs, and dissolves again, as you see to the eye, which convinces us of the truth.

From all these, it is evident, 1st, That the Salt and Water were only contiguous, and neither of this nature were chang'd. 2^{dly}, Heat quickens the solution, and causes more Salt to dissolve. 3^{dly}, That cold thickens the mixture and causes the Salt to subside. 4^{thly}, The Salt crystallises, but upon the Heat returning it dissolves again, and oil of Vitriol itself congeals by cold. 5^{thly}, When Water has dissolv'd, by being boil'd, as much Salt as it can, 'tis heavier than Water, and Brine is hotter than Water, as is try'd by the glass, when 'tis boil'd, and Brine requires more heat to boil it than Water, as you see. 6^{thly}, Hence Fire is the cause why Water is a

(a) I thought *Fahrenheit* invented this Glass! What is this freezing here to the fluidity of Water, by which it is properly a *Menstruum*?

Menstruum,

Menstruum, as freezing shews us; which begins at 32° to 72° , and every degree more Salt subfided, till spirit of Nitre itself turns into crystals, and the same cold hinders Water from dissolving Alcohol; for I expos'd in 1720 in the utmost cold, Beer, Wine, Vinegar, Brine; the strong Frost caus'd the Water of these liquors to turn into a soft Ice, but the spirits of these liquors was united and stronger, as I try'd, and the stronger the Frost grew, the stronger were they. 7^{thly}, Hence heat is necessary to make Water keep its contents from settling; these things apply'd to us and our humours, will have their use, which has been little thought of; Water then, which is the greatest ingredient in our blood, is subject to change from the weather; and urine, settling from cold, if you warm it, resorbs all its sediment.

One wou'd believe from hence, that Water as it heats wou'd always serve as a *Menstruum*, but the contrary appears, for warm Water dissolves Paste, whites of Eggs or Blood, but boiling Water hardens them.

The following are always dissolv'd in Water, 1. all natural Salts, as Nitre, &c. 2. all alkaline Salts, fixt or volatile; 3. all acids whatever; 4. all neutral Salts, tho' *Tartarus vitriolatus* is the hardest; 5. all *Borax's*, but with difficulty. 6. All essential Salts, of Plants. 7. All Tartars, but with difficulty, and they soon crystallise if the Water is evaporated; nay all Salts, except Borax, Nitre, Tartar, Tartar vitriolated, can hardly be kept from running; alkaline Salts run presently and attract water; oil of Vitriol sucks in Water greedily, Salt of Tartar hardly is to be parted from it, yet mix'd, they hardly dissolve; so in most mix'd Salts: It also dissolves saline bodies, as juices of all Plants or Trees, as Cassia, Manna, Honey, Sugars, and all Soaps, animal Juices, except

except Fat, Bile, the *offa Helmontiana*; Salts attract Water and Oils, Vitriols of all Metals; 'tis this Water that dilutes the Vitriols of Metals, and makes them mineral Water, 'tis this that makes Brass blue with Salt Armoniac, which when evaporated the Ochre or Copper drop; but Butter of Antimony, tho' a Vitriol, does not dissolve in Water; Earth thus dissolv'd in acids, will swim in Water, as Chalk, &c. but Glass will not, nor a human Stone; these being Earths made up with alkaline Salts. Hence it appears how acids help to dissolve our nourishment, it is in our stomachs, but afterwards our blood turns alkaline, or our bones might be in danger, for *Ruyfch* has often told me that bones put into acids grow soft and flexible, but do remain firm in Alkali's; hence in Rickets acids are bad, hence let care be taken that acids be not us'd to clean our Teeth; also Sulphurs mix'd with alkaline Salts will dissolve in Water; we have seen a *Panacea of Antimony*, which I discover'd, made of Antimony finely powder'd one pound, oil of Tartar or *Alcalhest Glauberi* two pound, digest, a red Tincture is given to the Salts, which tastes fiery, and is warming and diaphoretick, but common Sulphur wou'd do the same, for the Sulphur of Antimony and common Sulphur don't differ in virtue (b). Nay Antimony will give a Tincture to volatile Spirits, Mr. *Boyle's* Resins will also be dissolv'd in Water by alkaline Salts, fixt or volatile; hence putrefied Urine, burnt Wine Lees, Soaps, Sugars, Honeys, Choler, Yolks of Eggs, mix these

(b) I can't think so, our *Æthiops Min. Antimon.* is stronger than common *Æthiops*, and pray why do *Sibium* and salt of Tartar calcin'd prove caustick, nay, in a Tincture with spirit of Wine rectified, they are also caustic, p. 778. Vol. I? but because Salts open the Oil.

Resins with Water. As to the secrets of authors I know them not, *Helmont* boasts, but too boldly. Having now spoke of Water as a dissolvent, it remains I shew what are watry dissolvents.

Hail and Snow relate to Water, and these are Waters, which are pure; and Snow, as I have often said, is pure Water, if gather'd from a high place, and distant from any Town: Dew is the most compounded of all Water, and is a chaos of all things.

Of OILS and OILY MENSTRUUA.

I have already said what Oils are; there are different sorts, some are made by coction, others by expression, or fusion, as Pitch, or distillation, by exaltation or descent: Distill'd Oils don't congeal, express'd ones do; I have consider'd the difference of these Oils, but must rely on experience to determine it: This we know, that they will burn in Lamps; they prove *Menstrua* when they are thaw'd; and as some of them freeze sooner than Water, they are not so good dissolvents as Water: Those which always keep liquid, do always retain a dissolving property, as Oil of Linseed.

Most Oils don't boil till they arrive at 600° of heat, except the rarefied one, as *Ol. Tereb*; and as Water boils at 212° , therefore Oils are hotter when they boil than Water, and as they grow hotter, they prove better *Menstrua*: Water boils at 213° , Alcohol at 175° , but Oils of Turpentine and of Linseed don't yet boil, in *Fahrenheits's* Thermometer with Quicksilver; 'tis not levity nor volatility then that makes liquors boil sooner: Brine boils at 218° , Oil of Turpentine boils at 560° ; however, when this Oil grows thick, 'tis longer c're it boils; and the thicker 'tis, the longer

er 'tis e're it boils; Oil of Almonds boils at 600° and more: The power of Fire over Oil is to its power over Water as 10 to 3; Water freezes at 33° , but Oil does not freeze at 1° ; the middle term of Water between freezing and boiling is 180° , but of Linseed Oil is near 600° : Who would have known all this *a priori*!

Oils preserve bodies, tho' in the greatest natural heat, and bodies remain incorruptible in them; and if bodies be thrown into them whilst the Oils boil, they crust them over yellow, red, or black, and thus Meats may be preserv'd for ever.

Hence these *Corollaries* may be drawn.

1st, The degrees of heat given to bodies by fire are not in a Ratio of the Densities of heated bodies.

2^{dly}, However, the denser a body grows by consolidation, this fire may be more communicated to that body.

3^{dly}, The power of the greater fire to be communicated to any body does not depend on the combustibility in fire; boiling alcohol admits no more fire or heat, than which nothing is more combustible, and nothing in nature admits less fire than it; so far that we see it is in vain to seek for generals, we must try each particular properties of bodies; from hence many things may be gather'd, to wit, that we may dissolve Metals in Oils, so that 'twill be hard to separate them again: Red-Lead in powder thrown into Oil, boil, the Red-Lead is dissolv'd, it is a metallick balsam, and a cement to keep out Water; so granulated Lead half an oz. Oil Olive one oz. and half, also dissolves and runs Tin, and Lead and Tin together do the same, before the oil boils; melted Lead burns less than boiling Oil, because it melts with less fire than is requir'd to boil Oil; however, take care no Water falls into the Oil whilst

whilst it boils, lest it fly about and do great mischief.

Hence, 1. Oils have in them much fire e're they boil: 2. No liquid contains more fire than it does, for Oil of Vitriol, Lixivia, boil sooner, so does Quicksilver: 3. They hold much fire, e're they'll evaporate: 4. Oil communicates its heat to other bodies, and Lead and Tin melt before it: 5. It communicates its fire to Tin and Lead contain'd in it: 6. We know no other way than fire to communicate most heat to it, unless by compression added, hence it would receive more heat at the centre of the Earth; if Water should then fall into boiling Oil, Vulcano's would be bred: 7. The vessels containing it can be no hotter than the Oil, which hinders their growing hotter: 8. God then has bounded the fire, that the Oil should not expand immensely.

Crude Oils have much Water in them, they crackle in boiling, and their steams are Water: They also contain in them a hidden acid, as the smell and distillation convince us.

We are to consider whether the effects are produc'd from the Oil, or from this Water and Acid; for paints boil'd in Oil dry sooner, but if you paint with crude Oils, they never dry: Oils put into Brasses or Iron give a colour; Guns and brass Materials are defended from rust by boil'd and thicken'd Oils: *Boyle* and *Hoffman* observe, that put Salt of Tartar to Oil and you get a *Tartarus Vitriolatus*, and distillation shews the Acid plainly.

We must separate the foreign parts from Oils, before we know how to descry their effects.

Before we recommend Oils for *Menstrua*, we should examine how far they may be call'd Oils: Fetid or aromattick Oils distill'd, tho' 14 times, leave Earth, but become thinner, and a different *Menstruum*;

Menstruum; *Helmont*, *Hoffman*, and another brag-
gadocio, say good things of the Oil of human
Blood distill'd, often distill'd with Spirit of Salt.
See *R. Lully* and *Is. Holland*.

There is in Oils, and in no other body, an *Ar-
cheus* or *Spiritus Rector*, (c) which if evaporated,
the Oils are vapid and dead; one thing observa-
ble is, that Oils are capable of retaining much fire.

Oil then mix with Oils, not easily with Oils of
Turpentine or Amber, from the difference in
weight, thickness, &c. 2. Refins melt in Oils;
3. Gums; 4. Balsams, Colophonies; 5. Sulphurs,
solid or fluid; so Antimony in powder or flowers
makes a Balsam, the *Regulus* being untouch'd.

Of ALCOHOL or SPIRITUOUS MENSTRUUM.

Our Alcohol (d) is the same as that of the
adepts, for it does all that theirs did, except dis-

(c) *Helmont's* Term, he says, *Ens Cœlicum in se habet*, p.
88. Col. 2. he compares it to Salt Armoniac when it is ap-
ply'd to Spirit of Nitre, p. 89. Col. 2. No. 41. he calls it in the
same place a *Gas*; he says in the same place, *neque enim in
puttas cogitur, eo quod ex sanguineo arteriali cogitur*. P. 381.
C. 2. No. 26. he says, *Nisi res per saporem & odorem Archeo
priserint, non intro admittuntur*: In the same place he says,
*Alius proinde gustus lingua & alius in stomacho, velut Archei
extremo*. P. 116. No. 60. he calls it, *aura corporalis* and *vul-
canus*; he says 'tis material in Minerals and a thick liquid,
and in Plants it is more lively and liquid: In Quadrupeds it
rises and fluctuates, so those Eyes which when in a living
body shone, when dead lose that splendor, and therefore calls
it *Solar*; he calls it p. 121. an *Aura*, *vita Custos*, & *transmu-
tationum promotor*; that all Diseases begin at the *Archeus*, and
rise upon the *anima sensitiva*, and the *Archeus* which is the
motor of this Soul, &c. from all which we may gather his
Archeus to be somewhat *volatile*.

(d) Alcohol seems to proceed from אלל Deus, and אלל
ens, as if it were omnipotent.

solving fixt Salts; 'tis subtil, volatile, inflammable, extracts sulphurs, preserves bodies, &c.

However Alcohol, if you put dry Salt of Tartar to it, makes a tincture presently; all know it is prepar'd by fermentation and repeated distillation; it is a true and effectual *Menstruum*; animal and other Oils may be so attenuated as to mix with Water like Alcohol, but not so well; yet it contains Water, Oil, and Acid, tho' ever so highly rectified. 1. It dissolves Water; 2. Wines, Spirits, Vinegar; 3. Oils; 4. Resins; 5. Gum-Resins; 6. Salts volatile; 7. fixt Salts; 8. Soaps; 9. Sulphurs dissolv'd in fixt Salts; but it does not touch neutral Salts, Earth, Sulphur, Quicksilver, Metals, Semimetals, Stones, nor Gums.

Of ALCALINE and ACID MENSTRUA.

The word Spirit is an ambiguous Term, it signifies volatile, acid, and spirituous Liquors; we divide saline Spirits into Alcaline and Acid; Spirit of Salt Armoniac is a volatile Alcaline Spirit, we get such Spirits from Animals and acid Plants, when pure it is separated from the Oil; Acid Spirits are Oil of Vitriol, Spirit of Sulphur, &c. These are all Salts.

Alcaline Menstrua are necessary to be understood, being some of the chief *Menstrua*; I have diligently taken pains to discover what's useful in them, to impart it to you. Salt then is what can be dissolv'd in Water fus'd in the fire, if it flies not off, and gives taste to bodies: The figures of Salts, as to their component parts, are not to be discover'd by the Microscope, but unite into various figures when join'd into Earth, &c. 'tis therefore difficult to discover their virtues; give me leave to mention their various differences: Salt

then are divided, 1. into fixt Alcalies; 2. volatile Alcalies; 3. native Acids; 4. fermented Acids; 5. vegetable fermented Acids; 6. vegetable Acids prepared by combustion; 7. vegetable Acids prepared by distillation; 8. into fossil Acids prepared by distillation; 9. natural Salts, as Borax, Nitre, fossil Salt, Salt Gem, of Fountains, of the Sea, armoniac Salt; 10. Salts compounded of these: Of all which in order.

Of the fixt Alkali as a *Menstruum*. The word *Kali* (e) signifies a certain saline Plant, which burnt gives ashes that have a great deal of Salt in them, which we make as we do other common fixt Salts: This Lixivium is from *Lix*, Ashes, these Salts therefore are call'd Lixivial or Alkaline Salts; some also call it *Rochetta*, *Soda* or *Zoda*; with this Salt and Calces are made Fritt, from whence is made Glass; they also make Soap with Lime and Oil: These Salts are brought from *Alexandria* and *Tripoli*, and as our Senses give us our information, I shall give you the marks of fixt Salts; 1. 'tis got from an Herb; 2. made by fire; 3. where it continues long; 4. it runs in the air; 5. it tastes acrimonious and fiery; 'tis not urinous, but when tasted from the mixt Salt of *Saliva* 'tis made so; for, 6. it has not naturally an urinous smell; hence does that smell proceed from the Acid fixing upon the fix'd parts and letting the volatile free; (f) 7. they turn

(e) It signifies burnt, for, כך is *toftum*, or calcin'd; and to speak a Truth, the more volatile are Salts, the more do they recede from an alkaline nature; this plainly appears in a common Example, for Salt of Tartar attracts the Acid of Armoniac, and takes possession of it forcibly from the volatile part, which had enjoy'd it before.

(f) This is a grand mistake; fixt Salts do not turn urinous Acids, for they are only made so by the further attrition. But the 6th Section clears this up.

neutral Salts by Acids ; 8. with Turnsole, Roses, Violets they turn blue ; 9. applied for some time they will inflame and spacelate the parts ; 10. they are deterfive.

Such fixt Salts are made of all Plants, except those which have an acrimony or a scent.

They were known of old, for *Aristotle Meteor. C. 3.* mentions they burn the ashes of Reeds and Rushes, and boil'd in Water afforded a copious Salt ; and *Varro* says the Inhabitants of the *Rhine*, for want of Sea and Fossil Salt, us'd a coal of Wood made into Salt. *Pliny* says, those Ashes taste like Salt ; that the dregs of Wine burnt taste like Nitre, as did the ashes of burnt Oak ; and he says, that the lye of Ashes being drank is medicinal ; therefore the making of these Salts is not new. Since these Salts arise from the burning of Vegetables, how much must the Earth abound with them ! and in *Ormus* there are pillars of such Salts ; and as these Salts run in the Air and become neutral Salts thereby, therefore the Earth does not abound with these, but nitrous Salts, which contribute to vegetation.

These Alcaline Salts are never made but by burning, for if Plants be kept till they rot, they afterwards afford none of this Salt, they are therefore natural. (g)

These Salts are compounded of Earth, Acid and some Oil, along with a small quantity of Water made to cohere by the Fire, these Alcaline Salts do differ from each other according to the various mixtures and proportions of those mix-

(g) Vitriols are precipitated by alkaline Salts only ; know of none but fix'd and volatile, wherefore we must either call that Salt which is in Vegetables, a fixt, a volatile an alcalifate Salt, but an alcalifate Salt is referrable to none but the two above-named, and is an alkali *in potentia*.

tures, I shall recite the various species of 'em; 1. Pot Ashes are brought from *Russia*, they are made from the Ashes of Wood burnt, lixiviated, evaporated, and kept long in the Fire, by which they turn very acrimonious, which will run in the Air, which will with Sand make Glafs, which expos'd to the Air often will leave a great deal of Earth and turn volatile; they are call'd in Latin, *Ciner. Clavellati*, because the Woods, out of which they are made, are cut into *Clava's* or Chips: 2. Tartar which is the Salt of Wine, press'd out from the dregs, or the dry Tartar of various colours, which if distill'd gives acid Spirits and Oils, and at bottom is left an Alcaline Earth or black Tartar, which burnt, lixiviated, &c. become Salt of Tartar; these Salts, if join'd to any metallic parts, give different colours to Glafs; 3. the fixt Alkali of Nitre, which is made by letting Salt-petre flow, and throwing in Charcoal gradually till it will detonate no more; there is something particular in Salt-petre itself, for pour oil of Vitriol upon it, and it smoaks and affords an *Aqua fortis*, this Salt has all the qualities of other fixt Salts; 4. a fixt Salt is ^{made} of Tartar and Nitre, powder'd and detonated, which is also known to be Alcaline by all the aforesaid marks; however if you wou'd make a *Tartarus vitriolatus* from hence, the Nitre betrays itself by the smell. *Hoffman*, p. 231. Lastly a fixt and fiery Salt is made out of Salt-petre and the Regulus of Antimony, which is not to be born with, nay even a Tincture of this Salt with Alcohol is caustic; Nitre never grows alcalious with Sulphurs, but with the Regulus 'tis presently made: Alcalious Salts by fusing in the Air do attract Waters, and do hardly part with it under 600° of heat; one ounce of Salt will attract three ounces of Water and no more; hence this quantity must be supply'd from

six cubic feet of Air, supposing the weight of Water to that of Air, to be as 1000 to one, and a cubic foot of Water to weigh 64 pound, then all the heavy parts in a cubic foot of Air are $\frac{1}{125}$ of a pound, let half of this be Water, then in a cubic foot there's half an ounce; the more they are calcin'd the stronger do they attract it; *Sennertius*. This I tried another way, by shutting up fixt Salt in a glass Jug, quite dry'd; I stop't it with Cork and ty'd a bladder well moisten'd in Oil over all, and the Salt had attracted, even in the warm Air, as much Water as was in the Jug; these Salts repel Air, for try oil of Tartar *per deliq.* in the Air-Pump, and you can get little or nothing from it, or however they attract it so much that they will not part with it; fixt Salts red hot from the Fire unite with Alcohol, which if you suffer to attract ever so little Water, 'twill not do; all these Alcohols have somewhat of Acid, or make a neutral Salt, which is a *Sal purgans Sennerti*; we can rectify spirit of Wine by Tartar, which absorbs the Water and the grosser Oils.

e. alcohol
the Salts These Salts will attract distill'd Oils and make a Soap, but then the Salt must be dry, and these Soaps have a deterfive and an opening quality, they also do attract Oils by expression if mix'd with Lime.

These Alcalines do also attract Acids more strongly than they do Water, and make bubbles, and repel the Water; you can hardly deprive oil of Vitriol of its Water, but by fixt Salts, which then make a *Tartarus vitriolatus*, and this attraction varies with the differences of the Salts. *Homberg ac. R. Sc. T. S. p. 52.* says an ounce of salt of Tartar join'd to 14 ounces of spirit of Vinegar, and exhal'd, increase 3 drams in 36 grains, the rest was Water with spirit of Salt 2 ounces 5 drams, it

it weigh'd 3 ounces 14 grains, with an ounce of spirit of Nitre it weigh'd 2 ounces 2 drams 36 grains, with an ounce of *aqua fortis* it weigh'd 2 ounces 2 drams 36 grains, with an ounce of oil of Vitriol it weigh'd 2 ounces 5 drams. Hence the Acid in these bodies was not pure, till this mixture and exsiccation; 2. hence if the whole Water of spirit of Vinegar cou'd be evaporated, it wou'd be as strong as oil of Vitriol; 3. hence the quantity of Water is known in these Acids; 4. hence 'tis probable if the whole Water could be taken from these acid Salts, they wou'd be dry; hence may be understood why Alkalines and Acids huff so: when they huff no more, that is call'd the point of saturation, and the Salts then become neutral; hence Acids are call'd Males; Alkali's, Females; the Air and Water are expelled, and the Salts associate; do Acids abound with, and Alkali's want Air? Are Acids abounding in Animals, flatulent? Are mixt Salts less flatulent? Do Acids alone raise fermentation? Are they the reason of this motion in fermentation? does fermentation tend to an Acid, and ustion make Alkali's? Does fermentation want a small heat to breed Acids, whilst a great one breeds putrefaction? Hence Alkali's and Acids breed motion in nature; the Air and Water are expell'd, and these Salts join into crystals and into a powder, easily to be dried by the Fire, which the Acids or Alkali's do not alone; the force of the Fire separates them again, but not into those saline principles from whence they were generated, this is true in Salt Armoniac sublim'd, *Tartarus vitriolatus*, Sea Salt regenerated, Tartar and Nitre resuscitated; but there are ways by which they may be separated. Alkalines attract one Acid stronger than another, which we prove by experiments, saturate an Alkali with Vinegar, or let spirit of Nitre be pour'd

to *Tartarus regeneratus*, spirit of Salt of Sulphur or Vitriol will do, the Alkali attracts these and lets go the Vinegar, which may be easily call'd off by a little Fire; to an Alkali impregnated with spirit of Nitre, pour spirit of Salt, an *Aqua Regia* ascends, and the mixt Salt remains at bottom; if to Alkali you pour spirit of Salt so as to make it a common Salt, pour spirit of Nitre, distill, you get an *aqua regia*, and nitrous Salt differing from Salt or Nitre, remains at bottom, both repel each other and ascend, and both remain impact in the alcalick Salt at bottom; if with this Alkali sated by spirit of Nitre, you pour oil of Vitriol, the spirit of Nitre ascends pure, and you've a *Tartarus vitriolatus* at bottom; if to spirit of Salt or common Salt you put oil of Vitriol, you presently gain a spirit of Salt, which smoaks till it be redistill'd; hence the assertion is true and holds so in all cases; therefore the strongest attracter remains, therefore the Salt at bottom is a neutral one; 4. there is a great difference between these factitious and the natural Salts, for example, *Sal mirab. Glauberi* from *Tartarus vitriolatus* and the like; hence chymists are mistaken, in saying that these factitious are the same as the natural Salts; 5. when one Acid expels another, 'tis done without an effervescence, and therefore no Air is produc'd, which was indeed expell'd before, hence such changes and regenerations of acid Salts unheard of, which however can't be explain'd by any other principles.

Hence the following problems. Do Alkali's owe their origin to Fire? Do volatile Alkali's owe their rise to the heat of putrefaction? Can any Alkali expos'd to the Air remain long so? Do not Alcalies by meeting with an Acid turn neutral? And with oil of Soap? Does not the same thing happen in plants and human bodies? Are

Are not compound Salts produc'd every day? Are not compound Salts the most common of any, as *Tartarus regeneratus*, the Ophthalmick spirit of *Mindererus*, Salt of Fountain, *Sal Gem*, Sea Salt or Nitre? Do not these arise from an Acid and a fixt Alkali of Plants? Are not these simple Salts rather chang'd than divided? *Franciscus Travaginus* the *Venetian* and the famous *Otto Tachenius*, will have it that these Salts proceed from an Acid and an Alkali; but I think the Sea-Salt was prior to either Acid or Alkali; no one hitherto has been able to draw an Alkali from Sea-Salt, which I prove thus: Salt with Bole gives an acid Spirit, the remainder at bottom is saltish, wash this Salt off with Water, depurate this with straining, make Salt of it again, I found it still Sea-Salt nor any Alkali in it, nor is there any Acid to be got from the Sea-Salts by Art; I confess that these Acids being pour'd to Alkali's give regenerated Salts, which come near to mixt Salts, but there's always a difference 'twixt the one and the other, we must therefore take care when we alcalise *Menstrua* to be very circumspect.

Take fine Sand or Calx of Flint beat into fine powder 100 parts, Alkaline Salt 105 parts, mix them nicely together, put 'em into a Glass Furnace for an hour, so that they be intimately mix'd, encrease the Fire for five hours, mixing them all the while, this is the Frit for Glass, set them by for four or five months in a hogthead, so that they may mix perfectly, put this into a Glass Furnace they will make an unctuous Fluid, whilst they are melting they always throw up a scum, which must be taken off, keep 'em in fusion for two or three days; this matter the Glass-makers call their metal, which when cool'd is the best Glass; who would have thought this? The Alkali flows like Water upon the Fire, and makes the
Flint

Flint flow, the concretion is so much the stronger as the solution was more perfect; here the Alkalies lose their nature, in Glass one 3d part is Alkali, but the nature of it is chang'd when it turns into Glass, where there is no taste of an Alkali, nor any taste, no effervescing with Acids, it becomes very mild and more fixt after it goes into Glass, nor so easy to melt, and becomes when made Glass so ductile that you make images of it, will stick to the Iron Pipes and becomes very pellucid like Water; on which no Salts have any power; this is the last operation amongst Chymists: The *Alcabefts* has no power over it; don't we see the difficulty of explaining physical operations, suppose natural Philosophers had never seen Glass, what wou'd they think of it? Who wou'd have thought that Alkali and Calx of Flints would have made Glass; what then do Philosophers undertake to do, when they would explain the nature of Crystals and Diamonds, they must confess their ignorance, for they must know the nature of Fire, and the principles the bodies are made of, before they can pronounce.

Something adheres of an Acid nature to Alkali's, and the same may be said of Oils and Earths; according to which Principles we may know the varieties of Alkali's.

These Alkali's are so greatly inforc'd by an addition of testaceous or terreous bodies, that lime and they do make a strong caustic, as we see in the common caustic stone, which may be the *Sal Tartari inceratus*, which flows like Wax.

These Alkali's don't work upon Quicksilver, Gold or Silver; and if they have effect upon the other Metals, it appears to act upon their Sulphurs, so Antimony with salt of Tartar becomes a silvery Regulus, and the salt of Tartar is at top with the Sulphurs; if then *Tachenius*,
Boyle

Boyle and Homberg speak truth on the resuscitation of Metals, there is a secret way of making these Salts work upon the metallick fix'd Sulphur.

These fixt or volatile Salts act upon oily, balsamick, gummous, resinous Gums, and do contribute to make Tinctures, and neither *G. Hedera*, *Juniperi*, *Lacca*, Myrrh nor others will mix with Water or Alcohol without them; they also take off the Acid from bodies, and this bond being taken off, the bodies are readily united with their Vehicles. Quicksilver made into red precipitate, is not reduc'd with oil of Tartar, but settles into a powder; however by this Salt and Fire, you regain running Mercury.

Volatile Alkali's serve several purposes, they are found in Vegetables and Animals, but whether they existed before distillation or putrefaction is a Question, unless we suppose that Salt in *Acidule* resemble it, as *Hoffman*: Acid Vegetables afford it, animal Humours join'd with a fixt Alkali gives them out; their virtues are the same, but quicker, with fixt Salts; these fly off, which fixt ones don't, but act with the help of the first. These, if pure and apply'd with a sticking plaster over them, will give pain, inflammation, black Eschars, and in a short time will corrode to the bone, as in the pure spirit of Urine is known.

*Volat.
Alkali*

Of Acid Menstrua.

I have already given the marks of an Acid, they are generally in a liquid form, except the Crystals or Tartars of Plants; those of Vegetables are either natural or fermented; natural Acids are from the Juice of the Earth, for as Count *Marsilli* tells us those which grow in the Sea

Sea are alcalious; (b) in Plants, Sorrel and some others are four, the juice of unripe Fruits are four: It lurks in Woods, Spices, Gums, Turpentine, &c. and tho' these Acids are not pure, yet the juice of Orange, Citron, Lemon will corrode Lead, Tin, Copper and Iron; all these Acids may be turn'd into an essential Salt, or Crytals, call'd Tartars.

Fermentation betrays an Acid in bodies, which we call *vinous* Acids, and this Acid appears in Manna, Honey, Sugar, Wine, Ales, which are liquid or solid, as Tartar sticking to the Casks; we call all Acids then produc'd by Fermentation, *acetous*, which are of use in Chymistry.

The Acid that exhales from Wine fermenting in Cellars will strike Persons dead, or give them Apoplexies, Madnesses, and the like, as has been known; hence we understand how Drunkenness comes; hence Tremors, &c. *Cornaro* tells us, how he us'd to be faint at the Season when the Vintage was near, which grew upon him, till he got some new Wine; *St. André, that famous Anatomist*, tells us, that a person by drinking bottled Ale fell into a Cholera and choak'd him, *Ph. Transf.* hence appears the force of Acids; Ingredients put into fermenting liquors work in a mix'd manner, to Treacle made up with Honey and a number of other medicinal drugs, ferment, and work with an united force.

Burn Green Wood, so that each end is out of the Fire, what sweats out is Acid; hence we understand why smoak of Wood is so troublesome to the eyes, and why smoak'd Fish keep long and look red: Several Woods distill'd afford this Acid,

(b) Is there then no *Alkali* to be found in Sea-Salt? Of this more elsewhere.

as Guaiacum, Juniper, Oak and others, which corrodes Metals, which preserves bodies from putrefaction, and dissolves Herbs, and makes them act: The Acid in Fossils is too strong for human bodies, it dissolves Gold, Silver, Mercury; it is poisonous and not readily to be given, unless where there is a strong Alkali in the Blood, as in Plagues, Small-Pox, &c. It is scarcely found in Fossils, unless in mineral Waters, which I have said are rather Alkaline; wherever it fixes to bodies, it soon is drawn off; we find it in Sulphur, resembling oil of vitriol. In Alum, it is drawn from the Limestone; In Vitriol or Calcanthum, it resembles spirits of Sulphur and Alum by 560° of Fire, the steams from all these will suffocate; join any of these Acids to Oil, you have Sulphur, to Limestone you have Alum, and to Iron Vitriol; hence all Acids, the same. Acid of Vitriol is the heaviest, to spirit of Nitre, as 11 to 9, to spirit of Salt, as 11 to 8, to *aqua fortis*, as 11 to 9, to spirit of Vinegar, as 11 to 9, *ac. R. Sc. 1699, p. 47. Memoires.* 2. 'Tis the most fix'd of any, requiring 560° to get it; 3. they attract Water gradually; 4. pour on Water it grows hot; 5. by it we get spirit of Salt, of *Sal Gem*, or of Fountains, or of Nitre, by pouring upon them; hence calcin'd Vitriol and Alum mix'd with Nitre make *aqua fortis* readily, and at bottom you have *Nitrum fixum*, as you do with Salt; 6. it dissolves Iron, readily and Copper, but not Quicksilver under 560° of Heat; it dissolves Camphire into an Oil, which by Water pour'd on returns, Boyle.

The next acid spirit we have, is from Nitre mixt with Bole or powders of Bricks and distilling it, or by mixing Nitre with oil of Vitriol, or Calcanthum, or the Calx of Alum; we get *aqua fortis*, distill it how you will, we get the same

*Nitre
Acid*

same Spirit; this Spirit smokes, dissolves Silver into caustick Crystals, which Oil of Vitriol does with difficulty; it dissolves Mercury, Lead, and Copper, but will not touch Gold, and scarce Tin; and when once it has fix'd upon the Metal 'tis hard to recover it from thence, as appears in Silver dissolv'd, and red Precipitate.

Marina Acid
Sea-Salt is distill'd like Nitre, with three parts of Earth and one of Salt, or with Oil of Vitriol, or with the Calx of Alum or Vitriol, and the same Spirit is produc'd from *Sal Gem*; this Salt is the same distill it how you will, it smokes with heat, dissolves Gold, Tin, Mercury, Iron and Brass, but hardly Lead, and Silver not at all.

✓ True Spirits of Nitre and of Salt are two fluids nearly allied, yet differ; cohobate Spirit of Nitre upon Nitre, depurated well by crystallisation, you get good Spirit of Nitre, better'd by rectification; but if the Nitre is not depurated, the Spirit from thence will not dissolve Silver, but Gold; therefore in Nitre not depurated there is Sea-Salt, and Nitre and Salt make *aqua regia*; as appears by taking Salt and pouring Spirit of Nitre upon it, and distill; and at the bottom of the Retort we get Nitre, but the liquor distill'd is *aqua regia*. *Du Hamel ac. Sc. p. 158. Boyle.* Or put Spirit of Salt upon Nitre, distill, you get *aqua regia* stronger than common Spirit of Salt, the Salt at bottom is Nitre: *Boyle, Hoffman, Bohn.* hence *aqua fortis* is made *aqua regia* with Spirits of Nitre and Salt mix'd, as Spirit of Nitre with *Sal Gem*, Salt Armoniac, or common, or Fountain Salt, or Sea-Salt.

Corollaries. From no Acids, Acids are got; from Wine toss'd by a Windmill for three Days, is got good Vinegar: *Homberg ac. R. Sc. T. 2. p. ii.* Acids that are got by the fire retain their force for many Years, Vinegar only becomes insipid;

insipid; Spirit of Salt corrodes the glass containing it; Oil of Vitriol after four Years retain'd its dissolving power; hence these Acids lose their acid nature whilst they dissolve bodies, as appears when Spirit of Nitre dissolves Quicksilver; *Homburg*: and are changed into an insipid matter; hence may be inferr'd, that Acids spring up and perish: no body gets Spirit of Nitre but from Nitre, but Nitre springs from the Alkali of Animals and the Air, or from Spirit of Nitre attracted by an Alkali, or from fat Earths; *Boyle*: and hence 'tis evident that the acid Spirit of Nitre is got of Nitre by the fire, but that natural Nitre has no such Spirit at first; hence Acids dissolving bodies are made a *Tertium Quid*; Spirit of Nitre dissolves Silver, Lead, Tin, Copper, Mercury, Nitre, Antimony, and Emeny; which differ in smell, taste, colour, and density. Lastly, All Acids agree in some things and differ in others.

First, They all effervesce with Alkali's, such as Chalk, Coral, testaceous Medicines, Horn, Bones, Nails, Cloth, Quick-lime, Iron, Copper, &c. and they become saline bodies, (i) and can be diluted with Water and dissolv'd in it; hence, when Water dissolves such bodies, there is a latent Acid in them; when Acids dissolve these metallic bodies, they lose their acrimony: Let half an ounce and nine grains of Spirit of Nitre dissolve Crabs-eyes, saturate the body and the liquor will be insipid, and being diluted with Water kept in a moderate heat, will appear to be nothing but Water, pour in any fixt Salt and there will follow precipitation:

(1) N. B. 'Tis a grand mistake to call all these bodies saline, none being properly such but Acids mixt with alkaline Salts; whereas, when Acids dissolve Metals or Earths they are then Vitriols.

V pitation: All Acids agree in this, that when they have dissolv'd bodies they lose their further power of dissolving more; so if Spirit of Nitre has dissolv'd Mercury, call it off from that body, it will dissolve no more Mercury: They make vegetable juices red, as in Turnsole, Roses, and Violets; Vinegar recover'd from Lead is no longer Vinegar, but the Lead reviv'd is Lead again; so is Mercury from Spirit of Nitre: hence they do not change the body dissolv'd, but are alter'd themselves. (k)

These Acids differ from each other, in as much as some contain more Water than others, viz. one oz. of Vinegar contains 18 gr. of Acid; in one oz. of Spirit of Salt there are 73 gr. of Acid; one oz. of Spirit of Nitre contains two drams 23 gr. of Acid; one oz. of *aqua fortis* contains two drams 26 gr. of Acid; one oz. of Oil of Vitriol contains four drams and 65 gr. of Acid, and the whole remainder is only Water: *Homburg ac. R. Sc. F. 1. p. 52.* The Acid of Nitre dissolves Silver, not Gold; *Aqua Regia* the contrary; there the Acids are chang'd into a new body; what you get from the Vinegar after it has dissolv'd Lead, is an oleous Spirit; Spirit of Nitre is not so much chang'd whilst it dissolves Lead, then the Acid is more chang'd in one object than another; the Spirit of Vinegar is chang'd in Lead, it can never be got from Iron and Verdigrease, 'tis very strong: All Acids can be diluted with Water, they can be united with Spirits; so Al-

(k) In fact neither are chang'd, for the acid Spirit only becomes more concentred by this Solution, the Water being separated from it; for in such a Case, if you commit the body so dissolv'd to distillation, the watry part first ascends, and by a stronger fire the Acid mounts, which if you please to catch asunder, you may make the Acid, by blending them together, of the same strength it was first.

cohol

cohol with Spirit of Nitre, but the effervescence is very great; with Oils they raise flames, Oil of Vitriol and Alcohol raise a great heat, after these effervescences with Oils they leave somewhat bituminous.

Of NEUTRAL MENSTRA.

First, Salt Armoniac: 'Tis dissolv'd in Water and makes a brine; it attenuates and raises sweat, resists putrefaction, dissolves Gums and Resins, can be dissolv'd in spirituous *Menstrua*, dissolves the filings of Iron; good against Worms; if pour'd upon Copper and digested, then 'tis antiepileptical; its flowers drawn with Fossils make an inimitable *Menstruum* call'd the *Aquila Alba*: Sulphurs, Semimetals, and Metals thus treated become volatile; hence flowers of *Lapis Hæmatitis*, hence *Veneris*, hence *Martis*, &c. are made; flowers of Antimony are so prepar'd, 'tis look'd upon as a secret to open all bodies; 'tis not distill'd without some body join'd to it; it converts *Aqua Fortis* or Spirit of Nitre into *Aqua Regia*; with fixt Alkali's 'tis turn'd into a volatile Salt; 'tis made with Sea Salt, Urine, Soot, and other things mixt, hence 'tis a semi-volatile *sal marine*, its power of acting as a *Menstruum* is as a Sea Salt.

Sea-Salt; of which I have spoke a thousand times, is got from Mines, Rivers, and the Sea; this Salt dispers'd every where is a pickle against all putrefaction; Water and moist Air dissolve it, and make a good *Menstruum* of it; it serves the same purposes as Salt Armoniac; powder it, decrepitate it, it will vanish in the fire; mix it with Metals or Semimetals, it produces wonderful changes; with Antimony it gives a brownish mass in a Crucible; repeat this operation, it becomes more metallic, do it a third time; the Salt flies

TOM. I.

O

off,

off, and leaves a reddish, yellow mass of Antimony at bottom, hence Salt acts here as a dry *Mens-truum*; it is us'd in cementations along with brick-duft to exalt the colours of Metals, &c. 'Tis distill'd into a Spirit with brick-duft, which is a very strong *Mens-truum*: I have dissolv'd two pound of Spirit of Salt, so much pure Salt beaten small thrown in gently, I've put it into a viol and seal'd it hermetically, expos'd it to the heat of the Sun, from the 10th of May to the 10th of July; then I distill'd it till there remain'd at bottom a thick fatty liquor, in which were crystals of Salt; this Spirit I've pour'd upon fresh Salt and distill'd it thus for 25 times, drawn off the phlegm gently and redistill'd it, I have got a most acid, sharp, ponderous, oily Salt, and the Salt at bottom was very acid; I expos'd this Salt, it run in the Air, I strain'd it and join'd it along with the Oil, you get a liquor to be rang'd in the Class of *Menstrua*, which is worth your while; Boyle tells us by a long digestion Salt will distill with a little Sand, and that the Spirit came before the phlegm; and Du Hamel says that nine parts of Sea Salt dissolv'd, strain'd, depurated, and crystalliz'd, give out one part that will not granulate, which being taken away the Salt is the purer thereby.

Salt-petre is made of an Alkaline and an Acid Salt easily convertible into an Acid, 'tis easily chang'd in the Fire; as it melts it helps to promote the flux of Metals, then it detonates with sulphureous bodies and becomes a *Sal Polychrestum*; hence it melts with Charcoal, but flows no more after it turns into an Alkali; with Brick Calcanthum and other powders it turns into a spirit, and proves a *Mens-truum*, and corrodes Metals which I've already often told you. 5. Melt regulus of Antimony with Nitre, it becomes a caustic

6. it will detonate with Salt Armoniac, and grow into a new sort of Salt which is red; 7. with *Sal marine* and spirit of Nitre or *aqua fortis*, it makes an *aqua regia*, and the Salt at bottom will be Nitre in every respect; in like manner, if you pour spirit of Salt upon spirit of Nitre, and distill, it makes an *aqua regia*, and the Nitre remains at bottom, nay spirit of Nitre and any alkaline Salt being mixt turn Nitre, Nitre is also made of Salt, a fixt Alkali and Lime, calcin'd and expos'd to run; hence you may understand how it is a *Menstruum*.

Borax from the *Indies*, *Persia* and *Transilvania*, dissolv'd in Water strain'd and crystalliz'd, has a bitterish and sweetish taste, and is a neutral Salt; distill'd it affords Water and Glafs, which is soluble in Water, it affords no acid spirit mix'd with Sand, it promotes the Flux of Metals; hence who understands what has been said about native and other Salts, will easily understand, when they are compounded, what effects they will have; if volatile and fixt Salts are join'd together, the volatile are made stronger by the Fire, whilst fixt Salts attract the Acids and leave the Oils and Earth behind; hence they become different and of various efficacies, fixt Salts join'd to vegetable Acids make a compound Salt that's opening and diuretick, as Salt of Wormwood, and Juice of Lemons, &c. Volatile Salts join'd with Acids make another compound; the Acid join'd to the fixt Salt is penetrating and saponaceous, flows in the Fire and does great Feats, Vinegar and Salt of Tartar is *tartarus regeneratus* or *acetum radicatum* or *Sal tartari volatilis Helmontii*; these are an excellent *Menstruum*, Myrrh is best dissolv'd by such a Salt, it joins in with Alcohol, these mixt Salts make a neutral one, which is better than either Acid or Alkali, if a volatile Alkali be join'd

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with

with Vinegar, it has a peculiar virtue of dissolving, which you wou'd seek for in vain elsewhere, which is good in the eyes or ears, and any matter concreted, and Vinegar join'd with Urine is an excellent discutient, so volatile or fixt Salts join'd with acid Spirits or with Acids of Fossils produce other Salts, to Alum dissolv'd in Water, and warm'd, pour in warm oil of Tartar till 'tis saturated; the Calx falls down and the Water at top is a *tartarus vitriolatus*; so if to any Vitriol, we pour on a fixt Alkali, as warm oil of Tartar, you precipitate the Metal, and the liquor is a *tartarus vitriolatus*, only Copper in some part remains in the liquor and gives a blue, so in all mineral Waters Alkali's precipitate the Metal and leave the liquor a *tartarus vitriolatus*; when the Acids are join'd to volatile Salts, they make a Salt Armoniac, which may be call'd a *tartarus vitriolatus*, these Salts have a power of attenuating, opening and stimulating, when Salt Armoniac is join'd to any Vitriol, it makes a *tartarus vitriolatus* semi-volatile; part of the Vitriol falls, hence may you judge of the nature of these mixt Salts.

We will now consider the mixture of fixt Alkali's with Acids, produc'd with the Fire, when an Alkali and a distill'd Acid are join'd, they resemble Nitre, if the Acid of Alum or Brimstone or Vitriol are join'd with it they make a *tartarus vitriolatus*; if a volatile Alkali be join'd to a Spirit of Salt or *Sal Gem.* it makes a Salt Armoniac, if it is join'd with Spirit of Nitre or *Aqua Fortis*, 'tis Nitre; hence you see the varieties of mixtures and what differences they make but without an accurate knowledge in these things one can't understand the doctrine of *Menstrua*, if a pure Alkali be put to Salt Water, the Brine is muddy, an Earth falls and then the Salt become

pure by crySTALLISATION, a fixt Alkali added to a Lixivium of Nitre, Earth precipitates and the Nitre is pure; the fixt Salt Armoniac put to Brine, the Salt at bottom is fixt; the volatile Alkali being pour'd to Brine disturbs it and then flies off, if the same be mix'd with Nitre dissolv'd, it flies off and depurates the Nitre, if it be mix'd with Salt Armoniac dissolv'd, it also depurates it, but does not disturb the liquor; Vegetable Acids mixt with Sea Salt, Salt Armoniac or Nitre, change only a little, neither if they are distill'd; Vitriol and Alum calcin'd to a dryness, they retain a fixt and strong Acid, and if calcin'd Vitriol be put to Salt and distill'd, you get a pure Spirit of Salt, and at bottom there's a *Sal mirabile Glauberi*; if Quicksilver be beaten with calcin'd Vitriol, and mix'd with decrepitated Salt, distill you get a *Mercurius sublimatus*, which is only a vitriolick Salt; *Aqua Fortis* may be got from Alum and calcin'd Vitriol mix'd with Nitre; if these two be mix'd with Salt, they make a Spirit of Salt, if with Nitre and Salt an *Aqua Regia*; if Nitre and Colcothar be fus'd together, it makes a vitriolated Nitre: Sea Salt calcin'd with Colcothar makes a *Sal mirabile Glauberi*; hence Salts mix'd with Salts make always new Salts and new appearances arise, which both please and profit.

Menstrua do also produce new *Menstrua* when join'd together, moreover the reduction of each *Menstruum* to the utmost purity, and dividing them into their minute atoms, are what deserve the principal care of the Chymist; for example, I want a pure vegetable Acid, take Verdigrease, pour on the strongest Spirit of Vinegar twenty times distill'd, digest 'em, strain 'em, inspissate 'em with a gentle Fire till a crust appears at top, set 'em by to crySTALLISE, pour off the liquor

quor and take out the Crystals, inspissate this liquor again, and take all the Crystals you can find, this is a way of getting the pure Crystals, this affair succeeds only in Copper; this Vinegar may be made with any fermented liquor; *Zwelfer* thought by this he had got an Alcahest, but there is no end of new *Menstrua*, the Spirit of Bread would hardly be believ'd to dissolve what it does, *Tartarus regeneratus* will mix with pure Alcohol, which then is an alkaline and sulphureous *Menstruum*, it dissolves distill'd Oils, Spirit of Nitre saturated with Spirit of Salt Armoniac, we get a volatile Salt of Nitre; which may be a good *Menstruum*, thus have Chymists spent their time in finding out these inventions: And I recommend the same to your further labour.

'Tis my part to descend to some corollaries:

1. all these *Menstrua* do require some Fire to assist their operation;
2. they must be made fluid;
3. some act by attraction, and others have a power of acting within themselves, so Spirit of Nitre smokes, Spirit of Salt Armoniac is always in motion, which may be communicated from the Air, by this motion solutions often happen, which would not otherwise have happen'd; for example Chalk is not chang'd in the Fire, in Storms, in the Air, in Water, in a Lixivium of Salt of Tartar, but in Vinegar, and is dissolv'd there;
4. that which will corrode our bodies, will not corrode Sulphur or Wax, as appears in Oil of Vitriol;
5. *Menstrua* can't dissolve a great many bodies unless they have first been dissolv'd in another *Menstruum*; so Sulphurs is not dissolv'd in Spirit of Wine without Salt of Tartar; so Silver dissolv'd in Spirit of Nitre, then digested in a pure Alkali, then sublim'd with Salt Armoniac, you get a running Quicksilver, *Boyle, Homberg.*

chenius, which I have not yet experienc'd; 6. some bodies dissolve others, which you cou'd not have thought of; so Turpentine penetrates the body and makes the Urine smell like Violets, it also dissolves Resin, Gum Resins, Copal, &c. and the Yolk of an Egg dissolves it as well as other Gums, Oils and Resins, Balsams, Manna, Honey, Sugar, &c. *Helmont* praises the white of an Egg distill'd in preparing his medicated Mercury, and a white of an Egg boil'd to a hardness, and put into a Cellar, affords a liquor that dissolves Myrrh; 7. 'tis dangerous to pronounce *a priori*, what is a *Menstruum*, but experience must guide us; so if Silver be boil'd with Cream of Tartar, it becomes white, but with common Salt not at all; 8. nor must a Chymist determine by any reasons what has dissolv'd a body, being so many reasons for its dissolution, which are hard to hit upon; 9. all corrosion is relative between the matter corroding and the particular thing to be corroded, for example, *Aqua Fortis* corrodes Animals, Vegetables and Fossils, we can't therefore conclude that it will dissolve Wax; 10. we cannot say that because this *Menstruum* is mild in respect of our bodies, it will be so in respect of others, so Oil is not hurtful to us, but it will dissolve Sulphur and Wax, Wax takes out the colour from Coral, which the Fire will not; hitherto nothing has been found to cure the Stone or a Cancer, however we must not despair, for some time or other these remedies may be found out; Spirit of Rye-Bread has the power of dissolving some Stones, but does not hurt the human body, the Water and a White of an Egg boil'd dissolves many things, but hurts not the eye; 11. *Menstrua* do change their objects and are chang'd themselves, Water, Alcohol and Mercury are little chang'd, tho' somewhat; 12. 'tis an error to think that the

more pure *Menstrua* are made, the more they will corrode, Lead is better dissolv'd in Spirit of Nitre diluted, Iron in Oil of Vitriol diluted, Alcohol coagulates the blood, but dilute, it dissolves, on the other hand they are sometimes requir'd very pure, only Alcohol will dissolve distill'd Oils and Amber; 13. virtues are produc'd anew, by these mixtures; a person may take some grains of Mercury, he may also take some grains of Spirit of Salt, but sublimate which is made from these two is dangerous, so you may give 30 grains of crude Antimony to a Child; you may also give the same of Nitre, but when these two are mixt upon the Fire and detonated, they are made into a *Crocus Metallorum*, fix grains of which wou'd kill a child; hence precipitancy is to be avoided by Physicians and Chymists, Medicines casually hit upon must be tried in very small doses; try and then trust.

Of the universal Menstruum or Alcahest.

Whoever considers what is already said, will find that attraction and repulsion, except some few mechanical Affections are the causes of solutions, and every action depends upon a relation between these two, and hitherto no one body has been found capable of dissolving every body, and it appears to be impossible, however *Helmont* said *Paracelsus* possess'd such a secret, which he call'd Alcahest, which wou'd be a great blessing to mankind and a greater treasure than the Philosopher's Stone; so thought Mr. *Boyle*, who with all his diligence cou'd neither find nor believe such a thing; I shall set down the opinion of authors on this head, which however they extracted from *Helmont*, for from *Paracelsus* we meet with no such thing, and as I have

not the secret myself, I will give you what the authors say of this thing.

1st, *Paracelsus* calls it *Alcahest*, he tells us 'tis necessary to know to prepare this *Alcahest* for the curing many diseases of the liver, he mentions this word but once in his own works, the rest is all *Helmont's*.

2^{dly}, As for the Etymology, *Paracelsus* us'd to invert words, he call'd *Tartarus*, *Satrator*; he call'd *Crocus*, *Aroph*; and some say *Alcahest* is *Alcali est*; some think 'tis from *Saltzgeist*, that is *Sal Marine* coagulated, some think 'tis from *Algeist* or a pure Spirit.

3^{dly}, Thus far for conjecture: Let us now proceed to synonymous terms; first, *Helmont* calls it Water, which he would not publish, but which distill'd all Vegetables into a juice and threw the sediment down to the bottom; he says, he digested it with Charcoal in an hermetically seal'd Glass; he calls it also a thick Water like the Water in the *Maccahees*, which was a continual Fire; he calls it a dissolving Water, and he also calls it *Ignis-Aqua*, and says he had receiv'd a Jug, in which was the *Ignis-Aqua*; he calls it a Latex elsewhere reduc'd to the minutest atoms, and often calls it liquor, and says it dissolves all bodies into Water, he calls it *Ignis Gehennæ*, all which signify that it was a liquid; he says he dissolves Sand and makes a Salt of it; if this be *Paracelsus's* *Ignis Gehennæ*, we may know what it is; he afterwards says that it is a Salt, that it has attain'd the utmost subtilty, he calls it *Ens primum* of Salts, he calls it a circulated Salt in several places, if then *Helmont* was sincere, we may find out this *Menstruum*.

4^{thly}, But before we endeavour at this we will consider its origin; he affirms that Earth will be reduc'd into Water by art, that this can't be done without

without this Latex, and this is found out by Chymistry, by a long and tedious preparation, and that God Almighty is the only dispenser of this Secret, that neither reading nor the thought of Man could have invented it; there is, he says, but one dissolving Liquor that can reduce all things to their first matter, &c.

5thly, Let us now see the virtues of this miraculous Secret, it has a power of dissolving all things in nature, you may read him, p. 43. parag. 11.

6thly, Let us consider the manner how it works; he says that its virtue is excited by fire; that it dissolv'd Charcoal in three days by a gentle heat; that it chang'd every Oil and Spirit of Nitre into another shape; that it chang'd Cedar cut into chips into a milky Liquor in a week; that it pulverises Mercury in a quarter of an hour, whose weight was not diminish'd: He says, sometimes cohobation is necessary to make it work, particularly on Gold; that at one distillation it dissolves Stones; that by a second degree of fire 'tis distill'd, but does not ascend with a balneum.

7thly, Let us consider its effects; namely, it changes every thing into one mass, and that into a liquid: Quicksilver by it becomes fixt, other bodies become a Salt; Charcoal into two diaphanous Liquors; Cedar milky, and then divides into two Oils, which Oil turns into a Salt miscible with Water; a Stone taken out from the bottom of the *Schelde* near *Antwerp*, it turn'd in two hours by distillation into a Salt that melted; that Mercury refuses to be turn'd into a Salt; and these Salts after solution retain'd the seminal virtue of the simple body; by this dissolvent all things return'd to their *ens primum*, and enjoy their proper virtues: He says it dissolves all solid things into their first matter; hence it mixes with
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all the humours of our body, passes through all its vessels, and exercises its power where-ever it passes; it leaves this matter so dissolv'd, and is separated from it, but neither encreases nor diminishes the substance; hence it acts not by concreting with the body chang'd, nor melts it as Water does Snow; hence this *Menstruum* does not act by attraction or repulsion, but only by a certain mechanical power, contrary to all other things save fire; and, 2^{dly}, it preserves its own virtue, and destroys the poison of others: He says, that every body is chang'd into an actual Salt, which is equal in weight to the body from whence it is made, and that Salt often cohobated with this circulated Salt, is chang'd into Liquor; so Sand is chang'd into Liquor: He says he knows a Water that changes all vegetables into juices that have no dregs, which being distill'd with Alkali's becomes Water; that the Charcoal it dissolves turns into Water like Rain, and then it makes all things so volatile that they fly off and leave the Alcahest at bottom.

8^{thly}, What is wonderful is, that it changes all bodies, itself being not chang'd, and in this it resembles fire, which acts without being re-acted upon; after corrosion of Charcoal, it is at bottom as before; it knows not how to dye, 'tis single and joins in with no body. It agrees with *Helmont's* description of it, viz. That Salt of bodies being often cohobated with *Paracelsus's Sal Circulatum*, turns into Water, and this Alcahest is said to have the virtues of the *Ens Salium*: He calls it the most fortunate Salt, when pure, because it passes through all, being unchang'd itself; it acts wonderfully on Oil and Spirit of Wine; it reduces bodies to its own Liquor, and with it the *Ludus* may be prepar'd.

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But *Paracelsus* has a greater diffolvent than the Salt spoke of, and calls it *The Mother of the Salt of Mercury*: He acknowledges Fire and celestial Life, and a celestial quintessence in Quicksilver; when these two are united, we can have a *Mercurial Water*.— *V. Archidox* X. c. 6. he says, as Gold is not chang'd by being corroded, but may be reviv'd, so nor Mercury which is Water, with this Salt which is Water: The internal Mercury of Metals, he says, free from all Sulphur, is indissolvably connected, and obstinately refuses all division, &c.— I have found Mercury adequate to Water, for it contains no Earth, but is the Son of Water:— The fire does not change it, whether it flies off or remains on the fire:— It is homogeneal in its parts:— It is indestructible in its elements:— It is like the *Ens Metallicum* of Metals,— simple,— not a constituent:— It is only chang'd by its like.— Behold, my Hearers, the history of *Paracelsus* and *Helmont's* Alcahest; you see nothing from Urine can be this *Menstruum*, nor any thing of Tartar, nor Phosphorus, nor *Glauber's* fixt Salt of Nitre, nor *Zwelfer's* Spirit of Vinegar, nor *Rolfincius's* Salt of Tartar and Vinegar of Antimony, which is only a *Tartarus Vitriolatus*, nor *Tartarus Tartarisatus* of Vinegar and *Sal Tartar*; and from Salt of Tartar with four Whey we only get a *Tartarus Tartarisatus*. I am of the opinion of *Faber* in the *Eph. Germ. Anno. 8.* where he says, that Alcahest is a mercurial Spirit; that these two are made one; that it is indestructible tho' it destroys all; 'tis the true Mercury of the Philosophers; 'tis a milky but-tery Liquor, penetrating and dissolving all; 'tis simple and compound, the simple is made of a metallick Acid, the compound of this metallick Acid and the Salt of Animals and Vegetables; the Alcahest or Mercury of the Philosophers; 'tis

'tis mere Fire, unchangeable itself and destroys all other things: *Becher* thinks the same, he says in Sea-Salt is contain'd the Alcahest, which however differs from the Mercury of the Philosophers; he thinks that Mercury is a sulphureous Metal, and that its fluidity depends upon its arsenical Sulphur; this is a subtle speculation, and I wish he had demonstrated it: He tells us, that pure Silver dissolv'd in Spirit of Nitre and precipitated by Spirit of Salt becomes volatile, and dispos'd to part with its Mercury, therefore Sea Salt can convert the purest Metals into Mercury; if you ask my opinion what it is, I say that *Helmont* having complain'd that he had lost the bottle, he could not therefore try many experiments upon it; and *Paracelsus* does not boast of such great things from his dissolvent, for the rest, if you treat Mercury and Sea-Salt chymically, you will not lose your labour, but for the Alcahest, I know not what to say of it. (l)

Of the Chymical Vessels and Instruments.

By Vessels they understand those hollow bodies that contain things to be chymically treated, and by instruments I understand (m) those things which apply the materials to these Vessels; these chymical Vessels must be able to sustain the Fire and not be chang'd, we call these containing Vessels, those which receive the liquors we call recipients.

The matter of these Vessels in either of Wood, which contains Salts, to be shut up, or of Glass

(l) Why are such devious pains taken to prove the Philosophers old Maxim, viz. *De non apparentibus & non existentibus eadem est ratio.*

(m) See *Comenius's Janua Linguarum*. Cap. 86. p. 814.

which

which are not apt to spoil any thing put into them, and are to be made use of, when the Fire is not to be very strong, the white Glafs is apt to crack, but the green will bear 600° of heat; I wish *Helmont* had told us his secret for cooling of Glafs; the third is of Metal, and before all, Iron is the most preferable, the next are earthen Ware from *Hess* and elsewhere, they bear a strong Fire, yet they are apt to let spirits thro' their pores; those spiral Tubes for distilling of Vinegars are best made of Tin, the heads are best made of Glafs, these earthen Vessels must be coated where a great Fire is requir'd, these earthen Vessels are often made in the *Indies*, and purcelane Vessels are best to hold acid Spirits; as for the figure of Vessels, those glafs Vessels which are for holding volatile liquors, should have long cylindrical Necks with glafs stoppers, very close and well fitted. Those Vessels, which are for dropping liquors into, should be Jug fashion, with a cylindrical neck, with a broad margin in one place a little hollow, a Stopper of Cork or Wax if they be acid Spirits; see the Figure; we shall now treat of Vessels that are to contain, and those that are to receive bodies; 1. Crucibles are of a conical Figure, these Vessels if they are low and broad, the volatile matter flies off the easier, when a volatile matter is to be separated from a fixt one; the Vessels are of three sorts, Cylindrical, Conical with the base upwards or the apex upwards the cylindrical ones differ only as to height, they should be high to separate the less volatile from the fixt; and when Vessels from a narrow bottom become more expanded, as in Hemispheres then every point of the base sustains the incumbent column of liquor, whose altitude is taken from that point, to the point of the surface which is a perpendicular from that point to the

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Horizon (n). Hence 'tis plain the columns are shorter the nearer they are to the surface; hence a broad figure helps the elevation, and makes it more expedite; hence we have the idea of a retort, 'tis a hollow sphere ending in a cylindrical neck, whose upper horizontal line is a tangent to that sphere at top; (o) the lower line of its neck is a diameter of the same sphere parallel to that tangent, wherefore such a Vessel easily passes from the retort into this cylindrical opening, and so into the recipient, such a Vessel is fit for parting very fixt from the most fixt, as acid Spirits; the next of these retorts are bent, the liquors may drop down, but in such tedious distillations where bodies resist the ascent, I made cylindrical Vessels, as in the table; and instead of retorts for distilling Oil of Vitriol, I have made use of Jugs as the most secure, as you may see in the figure; the rule then is, the more difficult things are to be distill'd, the more convenient the figure shou'd be, of the receiving Vessels; such are the *Clavae* of the *Germans* and *Dutch* call'd cucurbits, and formerly urinals, in these liquors are let back again; then the length of these Vessels is to be consider'd, the higher they are, the more difficult will the sublimation be; the speculation of these three things has given rise to a new invention of making Alcohol at an easy expence, viz. a Cone is made of Tin, its base six inches in diameter, its vertex of one inch diameter, its height four feet, with a tube descending into another cylindrical spiral tube, call'd

(n) That is, in *English*, the Surface is not so deep as the Bottom, or is higher than the Bottom.

(o) This is *Notum per ignotius*; for every body knows what a Retort is, but few his Explication.

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a serpent, this is call'd a matraass, and which is a very convenient instrument for distillation and digestion, but are apt to crack: the figure of recipients is either Spheroidal or Spherical, they ought to be large and well cemented; see the table. Retorts and recipients would serve for all uses, unless more Volatiles are to be separated from less Volatiles; and here alembicks are requir'd, sometimes we must cohobate, that is redistill, for this purpose Chymists invented a *Pellican*, but as such Vessels are not easy to be had, two glass Viols will serve the turn well united, but they are not to be join'd till the body is warm'd, least the included Air by its expression should crack the Glasses.

Of LUTES.

Are Glues for hindring the Air to enter or Liquors to pass out; *A Lute for watry liquors*, is, powder Linseeds, out of which the Oil has been express'd, and mix it with the White of an Egg, this serves for closing the Vessels and for cracks, and a Paste made of this and Water, is a Lute for Brandy Spirits and volatile ones.

But this does not suffice for acid Spirits, then a bladder suffer'd to lie in Water till it grows viscous in a good Lute, but for the acid Spirit of Fossils, the Lute call'd *Sapientia* is fittest, and 'tis made of Colcothar, boil'd in Water till it loses all its Salts, mixt with equal parts of Quicklime and the White of an Egg; when 'tis dry it grows as hard as a Stone, or potters Earth and Sand finely powder'd and made into a mass with Water till it does not stick any longer to your fingers, to which add common Lime $\frac{1}{4}$, and make a paste.

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The coating for Vessels is covering them all over so as that the coating is between the Fire and the Vessel, this is necessary for glass Vessels, the best of which is made as before with Potter's Clay, Sand and Lime Plaister: And this is call'd Lorication.

Of FURNACES.

I shall now descend to furnaces, on which affair you may consult *Agricola* and *Glauber*; a Furnace is a machine to contain the Vessels and to apply Fire to them; hence in a Furnace the requisites are a Fire, and proper *Pabulum* along with a Chimney, an Air-place, and a Door, then care must be taken that the Fire be directed to the body to be wrought upon; 3. to keep the Fire equable, the least expensive are the best, the first condition is that the Fire being kindled may fall directly upon the body to be chang'd; which is obtain'd by the figure of it. 2. That the Fire be made of the least consumable Materials; 3. That the Fire be continu'd with an equal standard, for were the degree not to be determin'd we should have confusion: Hence first we must think of the quantity of Fire; next of the *Pabulum*; 3. of the degree mensurable by a Thermometer; 4. of the easy access of the Air and all its properties, as Gravity, Humidity, Heat, &c. 5. of the manner of its exit; hence broad Chimneys are the worst; now I shall describe to you the different Furnaces; the first is call'd the students Furnace, the second is for distilling from sand, the third is the *Balneum Mariæ*, the fourth is for an open Fire, the fifth is for distilling of

(p) See *Comenius*, C. 86. Par. 816.

Acids, and the last for Metals: As for the Furnace for the Alembic and the Serpent and Refrigeratory, 'tis known by every body: And thus I have put an end to the first part of our Chymical Institutions. (q)

(q) N. B. We have forbore to follow the Professor in his descriptions of the Furnaces, because they are sufficiently illustrated amongst the Figures and the Explications of them; and this we do to avoid nauseous repetitions so disagreeable to Men of Sense: Descriptions themselves are lame, seeing informs best. Among his Furnaces he says nothing of the *Athamor*, for which see *Le Febvre* and others; this is an *Arabick* or *Hebrew* word, from *אֹתֹר*, *Fornax*.

The END of the first Part.



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